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CHANGES IN INTELLECT WITH AGE: II. FACTORIAL ANALYSIS OF WECHSLER-BELLEVUE SCORES*

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A. INTRODUCTION

There have been many factor analytic studies of the Wechsler-Bellevue, the WAIS, and various foreign-language adaptations of these tests reported in the literature during the past 20 years. Some have been concerned with the factorial composition of the tests. Others have been directly concerned with the possibility that changes in the structure of, or in the factorial composition of, the behavior which we call "intelligent" are associated with age.

There have been dissenting conclusions reported among almost all of the studies. There have been reports that the number of factors in the Wechsler-Bellevue and WAIS range from two to 10. There have been conflicting reports on any possible relations between age, and the number of, or structure of, factors to be found in these tests.

There are several reasons for the variation in deductions. In part they are due to differences in (*a*) approach and applications of the factorial method, (*b*) criteria for factor extraction, (*c*) philosophical orientation which have affected decisions about rotation, and (*d*) the nature of the sampled population.

It is probable that the total factorial complexity of the Wechsler-Bellevue and the WAIS [which have been shown to be similar: Riegel and Riegel (14), Cohen (5)] may be too great to be adequately determined solely by analysis of the 11 subtests of the scale. This was demonstrated by Davis (7), who administered the Wechsler-Bellevue with a series of reference tests to 202 junior-high-school students ranging in age from 12 to 16. In his analysis of 24 variables, he found that the various subtests of the Wechsler-Bellevue each had loadings on one or more of 10 factors.

Saunders (15) has reported that an analysis of the WAIS given to a combined group of high-school seniors and college students produced 10 factors. His results did not properly describe the factorial composition of the test.

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He divided each subtest, except for Object Assembly, into split halves and so analyzed a 19-variable matrix (having omitted Vocabulary entirely). The use of split halves in this way requires that virtually all variance specific to a subtest be found on a common factor. If there are common factors that are distinct from the subtest specifics (and there almost surely are), then the total common-factor composition of his matrix was almost surely greater than that of the 10 Wechsler subtests (as distinguished from Saunders' 19 split-half forms of the subtests). The only way his correlation matrix could have had less factors than the 10 Wechsler subtest variables would be for several of the subtests used to have no specific variance. Therefore, in the absence of more definitive information, we feel that the best guide we have to the possible factorial composition of the Wechsler-Bellevue or the WAIS is Davis's analysis.

The validity of this statement depends on the presumption that the factorial structure of either the WAIS or the Wechsler-Bellevue does not vary with change in age. Evidence on this presumption is also inconclusive. Any resolution, however, of the problem of describing the factorial composition of the test will be dependent on whether or not it changes with age. This study is an investigation of this relationship.

Balinsky (2) analyzed Wechsler-Bellevue test results from six age groups to determine whether the test measured the same abilities from one age to another. The ages and number in each group were as follows: age 9, 70; age 12, 75; age 15, 93; ages 25-29, 135; ages 35-44, 121; and ages 50-59, 69. He used as his criterion for stopping the extraction process the nonoccurrence of a loading of about .316. It was not clear, but apparently he rotated only factors in which loadings of .316 or higher occurred. The application of a stable criterion for stopping the extraction process meant that he was using something close to the "Analytical" methods used today (i.e., whatever criterion for stopping that is put into the computer program).

He obtained a regular pattern of an increasing number of factors between age 9 and 25-29, and then an apparent decrease after that. The centroid factors extracted were 3, 4, 4, 5, 4, and 4, respectively, from the youngest to the oldest group. This suggested that the factorial complexity of the test varied with age. In each case he judged one less factor to be meaningful after rotation.

Balinsky's study was inadequate on two important counts. First, his samples were generally not as large as desirable, and second, he almost surely failed to extract enough factors, especially at ages 12, 15 and probably at 25-29, to achieve a meaningful interpretation of the factorial structure of the test. This latter deficiency probably is sufficient to account, at least in part, for many of the shifts in factorial loadings of subtests between many of his age groups. He used only nine subtests. This, too, may well have produced greater instability of results. The absence of the Vocabulary subtest and its high verbal loading would make a verbal comprehension factor less well determined.

The Thurstones (18, 19) using the PMA battery and very large samples had found nine primary mental abilities among college students, seven among eighth-grade students, and six among kindergarten children. These results have been challenged in part. But the apparent increase in complexity with age, up to young adulthood, is consistent with the Balinsky findings.

Birren (3), Cohen (4, 5), and Riegel (13) factor analyzed the Wechsler Intelligence Scales. Birren reported four factors for 99 subjects, ages 60-70, living in homes for the aged or general hospitals. Cohen (4), using McNemar's (11) criterion for stopping factoring, obtained three factors in the Wechsler-Bellevue from three psychiatric-patient groups who averaged 29 years of age. Analyzing the standardization sample of the WAIS (5), he reported as follows: ages 18-19, five factors; ages 25-34, five factors; ages 45-54, five factors; and ages above 60, four factors. He noted that the results of the oldest group were different, but did not do much in the way of interpreting the fact that this group was "deficient in factor five." Riegel (13), using the German version of the Wechsler (HAWIE), reported that there were no structural differences associated with age after comparing age groups 20-34, 35-49, 50-60, and 65+. She used the principal-components solution to extract factors. Riegel and Riegel (14) compared the results of Cohen's oldest group, Birren's elderly group, and their own oldest group by using a technique for rotating each centroid matrix to the same solution, and concluded that the factorial structures of the three tests are similar. They also concluded, without presenting direct evidence, that the age differences, reported in the past, were due to procedural differences—not to any inherent effects of age.

It was against this background of equivocal results that we decided to determine if there are demonstrable intellectual changes, as measured by Wechsler-Bellevue subtest scores, associated with age. We had a very large pool of Wechsler-Bellevue protocols. It appeared feasible to set up a sufficient number of groups of sufficient size, so that there would be a reasonable chance of determining whether, and approximately at what ages, changes, such as those found by Cohen, would occur.

B. Subjects

The subjects were 1283 residents of a Veterans Administration Domiciliary. Their mean Full Scale *IQ* was 100.69 with a σ of 15.13. Though their average *IQ* and variability is almost identical to the standardization sample, they do not completely match some of its socioeconomic characteristics. There were 164 diagnosed cases of brain damage; almost half of the subjects had never married; about 30 per cent of them came from rural backgrounds. The subjects represented all nine occupational classifications given in the Dictionary of Occupational Titles (20). Educational background approximated that given for males in the 1940 census.

C. Method

The subjects were subdivided into six groups. Six intercorrelation matrices were calculated on the raw scores of the 11 subtests. The complete centroid method of factor extraction of Thurstone (17) was used to extract factors from each correlation matrix. Estimated communalities were the highest intercorrelation coefficient in a column, and these were not reiterated. The estimated communalities turned out to be surprisingly close to the obtained communalities; so reiteration would have had very little effect. Factoring was continued until the product of the two highest loadings in a centroid factor was less than .04. This was a rather arbitrary criterion, but it was low enough to insure that the final residual matrix would have very little variance left in it; much less, for instance, than would have been the case if McNemar's criterion had been used.

Rotations were first carried out using a program for the Pinzka-Saunders Oblimax (12) solution for analytic rotation to simple structure. This program has some difficulties which may have affected the results, moderately. The nature of oblique rotations is such that they largely preclude the rotating out of residuals. Probably because of this, we obtained in most of the older groups one or more very poorly defined axes. Although there was a considerable amount of consistency from one rotated solution to the next, the salient loadings of tests on factors were not as consistent as might have been ideal. The Oblimax rotations appeared equivocal as to the possibility that structure was changing with age.

Since we could not be certain of how much the variations in structure we obtained in our Oblimax rotations were attributable to either the method or the problems remaining in the machine program, we decided to seek clarification by re-rotating with the Verimax solution of Kaiser (10). The Verimax solution makes it more likely, but may not guarantee, that if one extracts more factors than the rank of the matrix the excess centroid factors will be rotated out as residuals. The results of this solution were generally in agreement with those of the Oblimax, but were definitely more consistent, both in apparent demonstration of age-related changes in structure and in stability of factor loadings from one matrix to the next. In all cases the rotations were computed to the criterion stated in the program, and no further adjustments were made.

D. Results and Discussion

Many of the results are summarized in Table 1.[1] It will be noted that the arbitrary criterion used to determine when to stop the factoring process resulted in a generally decreasing number of factors being extracted. From the means and σ's of the distributions of residuals it is clear that the diminishing number of factors extracted was not related to the amount of covariance left in the matrix. There did appear to be a slight tendency for the average of the r_{ij}'s in the correlation matrices to increase through the two youngest groups, but this is by no means certain. The overall variability of the r_{ij}'s also failed to show any meaningful age-related trend. This means, then, that the potential age-related change in factors extracted was not determined by varying degrees of correlation to any great extent. Neither was it associated with more covariance being left in the residual matrix nor with less total covariance being accounted for. This last point is illustrated by the obtained communalities which are presented in Table 2. There are no clear age-related trends in the table. Arithmetic, Block Design and Object Assembly may show a decreasing trend, but Comprehension and Digit Symbol may be increasing. It will be remembered that these obtained communality estimates were not reiterated, but were generally close to the estimated communalities used. The Block Design estimate was about .15 high for the youngest group. This difference declined with increasing age to zero in the oldest group.

The rotated matrices showed quite definite and rather stable changes which were even more markedly related to changing age than was true of the number of axes extracted for the centroid matrices. For the three younger groups, there was no instance of a clearly residual factor emerging among the rotated

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[1] A set of tables showing all means, standard deviations, intercorrelations, and rotation matrices has been deposited as Document number 7747 with the ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D.C. A copy may be secured by citing the Document number and by remitting $7.59 for photoprints, or $2.75 for 35 mm microfilm. Advance payment is required. Make checks or money orders payable to: Chief, Photoduplication Service, Library of Congress.

TABLE 1

Summary of Results of Analyses of Six Groups of Adults

Age of group	N	Mean and σ of r_{ij} M	σ	Centroid factors extracted	Factors rotated	"Meaningful" factors	Mean and σ of last residual r_{ij} M	σ
Under 29	129	.415	.102	6	6	6	.000	.018
30-44	207	.479	.134	7*	6	6	—.002	.012
45-54	227	.501	.092	5	5	5	—.001	.024
55-59	315	.497	.089	4	4	3	—.003	.014
60-64	282	.500	.150	4	4	3	—.004	.015
Over 65	123	.510	.125	4	4	3	—.001	.019
Total	1283							

* In the 30-44 age group the 7th axis had .13 for its highest loading and was excluded from the rotation.

TABLE 2
COMMUNALITIES OF THE SUBTESTS AFTER THE INDICATED NUMBER OF FACTORS WERE EXTRACTED

	To Age 29	30-44	45-54	55-59	60-64	Over 65
No. of factors	6	6	5	4	4	4
Comp.	580	689	685	657	735	696
D. S.	474	537	547	557	502	532
Arith.	698	725	653	675	629	632
Simil.	675	707	669	598	731	738
P. A.	538	637	570	516	637	588
P. C.	570	768	604	575	639	695
B. D.	797	757	714	723	683	639
O. A.	514	638	600	536	510	497
D. Sym.	337	448	523	622	420	579
Infor.	803	814	769	752	762	776
Vocab.	735	837	836	693	878	859
Total	6.721	7.557	7.170	6.904	7.127	7.231
Per cent on first two axes	83.56	84.28	88.04	93.11	94.65	93.34

matrices. For the three older groups, in each case four factors were rotated and three factors were found to have loadings above .30.

Factor matching between groups was carried out on a purely judgmental basis. The "factors" that were obtained and the groups that had loadings on the various factors are shown in Tables 3A-3H. The residual axes are shown in Table 3I. It is obvious that a great many of the results were consistent from group to group. For instance, factors one and two were clearly the "Verbal" and "Performance" factors that have so often been found in other analyses. They occurred in every group.

We will return to the question of interpretation of factors later, but first there are some interesting trends which are apparent when one looks at the

TABLE 3A
FACTOR 1 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

	Age					
Subtests	Up to 29	30-44	45-54	55-59	60-64	65+
Comp.	—348	+600	+415	+717	+778	+736
D. S.	—219	+274	+273	+367	+552	+488
Arith.	—515	+421	+379	+509	+661	+512
Simil.	—608	+682	+457	+668	+797	+748
P. A.	—237	+465	+401	+389	+416	+354
P. C.	—247	+386	+402	+445	+467	+548
B. D.	—218	+325	+298	+233	+412	+302
O. A.	—120	+153	+187	+217	+122	+114
D. Sym.	—283	+150	+329	+317	+310	+317
Infor.	—857	+842	+802	+806	+834	+827
Vocab.	—783	+869	+804	+748	+893	+888

TABLE 3B
FACTOR 2 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age Up to 29	30-44	45-54	55-59	60-64	65+
Comp.	+247	+300	—205	—275	—321	—205
D. S.	+323	+182	—243	—278	—101	—194
Arith.	+607	+314	—220	—308	—214	—305
Simil.	+232	+238	—264	—298	—297	—330
P. A.	+337	+384	—340	—595	—661	—611
P. C.	+364	+676	—454	—610	—623	—617
B. D.	+783	+645	—673	—750	—701	—723
O. A.	+535	+755	—729	—667	—699	—686
D. Sym.	+305	+331	—492	—627	—474	—579
Infor.	+177	+201	—171	—243	—221	—257
Vocab.	+150	+184	—268	—253	—274	—184

TABLE 3C
FACTOR 3 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age 30-44	45-54	55-59	60-64	65+
Comp.	—196	+208	—158	—061	—208
D. S.	—642	+593	—578	—430	—505
Arith.	—637	+589	—562	—344	—521
Simil.	—102	+265	—251	—074	—205
P. A.	—147	+166	—103	—072	—218
P. C.	—207	+210	—068	—128	—078
B. D.	—279	+292	—326	—056	—138
O. A.	—134	+097	—105	—026	—107
D. Sym.	—180	+398	—344	—216	—374
Infor.	—240	+178	—192	—109	—137
Vocab.	—188	+225	—262	—087	—163

TABLE 3D
FACTOR LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age Up to 29	30-44	45-54
Comp.	+250	—090	—073
D. S.	+154	—114	—167
Arith.	—003	+002	—011
Simil.	+274	—079	—109
P. A.	+586	—398	—359
P. C.	+574	—312	—332
B. D.	+347	+026	—048
O. A.	+188	+007	—103
D. Sym.	+254	+085	+021
Infor.	+051	+042	—009
Vocab.	+262	—076	—146

TABLE 3E
FACTOR 5 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

	Age		
Subtests	Up to 29	30-44	45-54
Comp.	+284	—437	+650
D. S.	—076	—050	+182
Arith.	+082	—088	+337
Simil.	+409	—347	—554
P. A.	+084	—041	—371
P. C.	+084	—139	+285
B. D.	+045	—190	+291
O. A.	+124	—001	+118
D. Sym.	—081	—032	+119
Infor.	+079	—044	+253
Vocab.	—068	—005	+215

TABLE 3F
FACTOR 6 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age Up to 29
Comp.	—498
D. S.	—538
Arith.	—241
Simil.	—092
P. A.	—127
P. C.	—181
B. D.	—114
O. A.	—211
D. Sym.	—126
Infor.	—091
Vocab.	—140

TABLE 3G
FACTOR 7 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age Up to 29
Comp.	—080
D. S.	—046
Arith.	+022
Simil.	—026
P. A.	—042
P. C.	—083
B. D.	—047
O. A.	—344
D. Sym.	—278
Infor.	—138
Vocab.	+079

TABLE 3H
FACTOR 8 LOADINGS ON THE SIX AGE GROUPS (VERIMAX ROTATION)

Subtests	Age 30-44
Comp.	+036
D. S.	+028
Arith.	+189
Simil.	+219
P. A.	+292
P. C.	—052
B. D.	+346
O. A.	+165
D. Sym.	+525
Infor.	+051
Vocab.	+080

TABLE 3I
RESIDUAL AXES FROM THE THREE OLDEST GROUPS (VERIMAX ROTATION)

Subtests	55-59	Age 60-64	65+
Comp.	—205	151	263
D. S.	—102	046	—025
Arith.	068	—169	073
Simil.	—014	—016	165
P. A.	012	149	—204
P. C.	009	130	083
B. D.	005	—141	074
O. A.	—181	—078	049
D. Sym.	100	—233	—055
Infor.	079	—085	—089
Vocab.	—003	—022	—100

remaining factors found in our results. Factor three, primarily involving the Digit Span and Arithmetic subtests, appeared in every group except our youngest. The factor may also include Digit Symbol. The factor appeared in every group in Cohen's studies (4, 5) as well as in Birren's (3). This failure to appear in the youngest group probably represented an accident of sampling fluctuations or (and) rotations. What occurred as our factor six in "the up to age 29" group may be the axis but, if it is, it is slightly lost or confused. This could happen if in this group the "actual" number of common factors exceeded the number of factors extracted. When there are too few axes, one or more of those present will probably be located somewhere between two clusters of otherwise largely independent sets of test vectors.

While there was good agreement between the studies on these first three factors, the agreement largely disappeared on the remaining factors. Cohen's (4) fourth factor was loaded only on Picture Completion, whereas our fourth factor was loaded on Picture Completion and Picture Arrangement among the three youngest groups. Birren (3) found no such factor. Similarly, the three youngest groups in our study had a factor involving primarily Comprehension and Similarities, but had Block Design and Object Assembly with it. Cohen's study showed no such possibility at all. Finally, within our data there occurred three instances of a single nonvanishing and quite uninterpretable loading on an axis—two of them in the youngest group and one in the 30-44 group. These three axes had no parallels in the other studies reviewed.

The breakdown of factor agreement between studies beyond the third factor seemed to us to be in part due to the age-related trend we have noted. The difficulty also seemed highlighted by such differences as were observed between our oblique and orthogonal rotations. In our orthogonal solutions the age-related trend is highly consistent as we go through the six age groupings. There was no exception to it. The oblique solutions we attempted were equivocal as to whether two of the oldest groups had three or four factors. We have already noted that some of that difficulty was probably due to the characteristic of the oblique solution. Some of this ambiguity arose from the fact that loadings in general were much smaller because of loss of covariance due to the reduction of angles between axes from 90 degrees. In spite of this general loss, there was a clear trend for number and magnitude of loadings on factor two to increase with age. This did not occur on factor one, which was, except for age group 60-64, loaded only on Vocabulary and Information.

No matter what happened in the oblique solutions, we still were confronted with a highly regular result that accrued from the orthogonal solution. Could it have been an artifact? Was there anything in our methods which would have by some strange coincidence been related to the age variable? We doubt it very much. In fact our methods would have to some extent stacked the cards against such a consistent outcome. Our communality estimates were neither computed nor reiterated; we simply used the highest correlation in the column. Our method of determining when to stop factoring was highly arbitrary, and might well have been subject to chance variation in when we stopped. In fact this probably happened in the 30-44 group. We might well, then, have expected variability in our results. There was very little.

One cannot help but wonder about still another problem. If the factorial complexity of the total test is in fact so large, how is it that we could get a residual in any group? We did not get residual factors when we rotated the matrices from the three youngest groups. We did, from each of the three oldest groups. Does the occurrence of residuals imply that the factorial complexity of the test is in fact being spanned by the analysis? One can immediately point out that if the number of factors that can be uniquely defined by the 11 variables used is less than the number of factors in the matrix, then residuals should not occur. But they could occur, if among the 11 subtests used, several factors are, for that restricted battery, specific to single tests. If this happened, it should have happened for all age groups. It seems quite possible, then, that the confusion—especially in the factor description of the youngest age group and to a lesser degree in the 30-44 group—may have been due to a complexity of structure that the battery was not sufficient to handle. It is also quite possible that there actually was a lower complexity in the oldest group.

If, as it appeared, there was a change in the number of factors with age, then the question as to the possibility of making definitive interpretations of factors would have to be answered in terms of the ages of the subjects involved. It may be that for the younger subjects no definitive interpretations of factors could ordinarily be made, because within the 11 subtests used the factorial structure is too complex for a battery of this size properly to span the space. Ordinarily, under this condition, some or all of the rotated factors would be expected to represent composites or mergers of factors which would be found to be most highly correlated if we had a space sufficiently complex to describe them all in detail. Such a circumstance would preclude making interpretations with any great confidence.

In our results, however, the factorial space does seem to have been adequately spanned in the three older groups. For this reason we can justify an attempt to identify those three factors, and thereby interpret the corresponding factors in the three younger groups. Factor one seems clearly to be either a "verbal comprehension" factor or perhaps, better, a factor involving the use of verbal, abstract materials to handle concepts. Factor two has normally been referred to as a "performance" factor. It appeared to us to involve the use of, or the manipulation of, concrete materials. These two factors appeared to offer an interesting contrast between verbal-abstract and concrete modes of behaving. They were correlated to some degree, although we have not estimated this correlation. Between them they obviously accounted for the bulk of the covariance in our matrices. This was true for all groups, but was relatively somewhat more pronounced in the older groups.

The third factor which appeared interpretable involved Digit Span and Arithmetic most clearly. This factor seemed best interpreted as immediate memory. That certainly is the most salient feature of Digit Span, and is also of necessity important to success in a mental-arithmetic test. The remaining factors, which appeared in the younger groups, we have not attempted to interpret. Perhaps the most interesting puzzle of our results is that they did disappear. But where did they go and why?

Perhaps before going further we had better state our conclusion in what we believe will be its most defensible form. We feel that in the light of our results—along with the results of Cohen (5), Birren (3), Balinsky (2), etc. —there is now sufficient evidence to warrant a clear conclusion that there is in fact a change in the factorial structure of the covariances of the responses people make to the various subtests of the Wechsler-Bellevue, as one tests samples stratified according to age. We have to state this conclusion this way, because we do not know why the change occurs. We suggest that the problem is no longer whether it happens, but why it happens. We hope that the question might now be attacked as opportunities arise.

Various possibilities are immediately available. It might be that there actually is a change in the factorial complexity of the test as age increases. On the other hand, since we have used stratified samples, it might be that the experiential (including educational) histories of the various age levels are in fact different enough to produce such a result. In an earlier paper (*J. Genet. Psychol.,* 1963, **103**, 3-21) we have shown that results obtained studying mean changes on the subtests were different when one compared stratified with longitudinal samples. Such a difference might not appear in factorial analyses. A longitudinal study would be the best way to approach the problem. But the first of the two testings would have to occur in the 20-to-40 age period, and then the second should occur after the person is 55, and preferably about 60. Such data may be difficult to collect or to find; but, until such data are found, the possibility cannot be completely discarded. We do have longitudinal data from an 8.65-year interval between 56.33 and 64.98 (in preparation). These data are consistent with the findings reported here, but the first testing was not at as early an age as would be desirable.

One might reasonably wonder about specific factors in our sample. About 12.5 per cent of our sample was brain-injured. These cases were spread throughout the age groupings, and so should have affected all matrices similarly. A disproportionate number had not been married, but this should affect all groups about alike. We have no evidence that any variables except aging itself, or possible differences due to cultural changes associated with having been reared at different times, vary with the factorial changes we have reported here.

What might change with age? We can suggest at least three possibilities. There has been quite a bit of speculation (1) that there might be a lifetime trend which goes from the general to the specific and then back to the general in the functioning of the intellect. Cohen (6) has analyzed three age groups of the WISC, and presented results which he feels negates this hypothesis so far as children are concerned. We doubt that he has laid the hypothesis to rest. He extracted five factors from each age group, partly because that was what he had obtained from all but one of his WAIS populations. He used oblique rotations, which apparently are less prone to allowing for residuals to occur than are orthogonal rotations. His factors match rather poorly from group to group, and not nearly as well as either his or ours do for adult populations. In one case Vocabulary is not even loaded on the verbal factor.

A general-to-specific-to-general hypothesis might seem reasonable if one thinks of Thomson's (16) sampling theory of factors. As we grow, we are taught a great many things in rather compartmentalized units. This goes on until we have finished school and undergone the early portion of our working careers. With aging may well come any of three phenomena. First, there may be a positive process involving a gradual integration and interrelating of our previously learned subpools of "bonds," or at least of those we manage to retain. Our results suggest that this "merging" either progresses toward two rather large pervasive factors, or tends toward evolving as one large or dominant interrelated pool (but producing two classes of people according to their preferred mode). This possibility seems to gain some support from the observation that at the beginning of habit acquisition, brain-wave activity is general and unrelated across various parts of the cortex (9). Changes in extent of unrelatedness and in relative activity levels can be observed as acquisition progresses. Bonds or associations have to be built up, and this building-up process undoubtedly extends through a major part of our lives.

There appears to be a trend in our data which would lend support to this idea. Consider the results from our factor four. The factor is obviously correlated with both factors one and two, even in the three groups in which it occurred. In fact, if one sketches a series of two-dimensional plots he will see that these correlations between factors appear to be higher in the 30-44 and 45-54 groups than they are in the youngest. It may well be that this factor was so highly correlated with either or both of factors one and two that it simply merged with them in the older groups. One might further speculate that the merger was predominantly with factor two since the loadings on the Picture Arrangement and Picture Completion subtests on factor two are, on the average, quite a bit higher in the three oldest groups than they are in the three youngest groups. A similar line of speculation appears to hold for factor five, which would most likely have merged with factor one.

A second possibility is a negative one. It might be that there is a change due to disuse and forgetting of many of the things that we are called upon to learn and do in our early formative years. Certainly part of the general decline in raw scores which is associated with aging (after 30) can reasonably be attributed to this source. Many people never again hear of the *Iliad* after they leave school. For this possibility to account for the change, we would have to expect that the crucial or retained dimensions narrow down to two, and this seems unlikely in the light of the complexity of our society and its demands.

The third possibility is not really independent of the first two. One can conceive of long-term trends toward adopting one's strongest potentialities for development as a pervasive mode of response in situations requiring intelligent behavior. It may well be that many people tend toward the concrete manipulation of objects, others to abstract-verbal-ideational modes of dealing with problems. Such a choice might be either genetically determined or determined by experience and reinforcement patterns.

Finally, as a parting question, one cannot help but be fascinated by the possibility that the structure of intellect as described in a current theory developed from the work by Guilford (8) and his associates might change along a time dimension. Their work has largely been done using relatively high-level personnel, from various sources, who were in their twenties. Would detailed replication be possible on an elderly group of, say, 60-year-olds? Would it be possible, in particular, if one used the Verimax solution to the rotation problem?

E. Summary and Conclusions

1. There appeared to be a definite change in the factorial complexity and description of the 11 Wechsler-Bellevue subtest scores as one analyzed successive stratified groups from the twenties to over 65 years of age.

2. The 11 Wechsler-Bellevue subtest scores apparently can be satisfactorially spanned by a three-dimensional space for groups aged 55 and up. For groups in their twenties at least six factors are required. The three factors in the elderly groups can be thought of as a verbal-abstract, a concrete-performance, and an immediate-memory factor.

3. The disagreement reported in the literature concerning the factorial complexity of the Wechsler-Bellevue is more apparent than real. The variance in reporting findings resulted, in part, because the various investigators who used groups of different ages failed to associate differences in outcomes with differences in the ages of their groups.

4. Part of the confusion in the literature is probably also due to the use of oblique solutions in some studies. These largely precluded the emergence of residual factors.

5. Some explanations for change in factorial complexity with increasing age were presented.

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CHILDREN'S REACTIONS TO FAILURE*

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A. PROBLEM

Despite increasing interests in the area of personality development, there have been relatively few experimental studies concerning children's reactions to failure. Psychologists believe that adequate responses in failure situations are important to the individual's emotional adjustment. Yet, when children are confronted with a difficult situation, one may observe wide variations in their reactions. Some children will try to find a solution persistently without emotion, while others immediately ask for assistance. On the other hand, some may become angry, cry, rationalize, or retreat from the situation.

One of the most frequent empirical investigations cited in the literature concerning children's reaction to failure is by Keister and Updegraff (5). However, in this study little is mentioned concerning the reactions of children with respect to age and sex differences. The purpose of this investigation was (*a*) to note the frequency of behavior responses which a child of preschool age gives when faced with failure, and (*b*) to compare these behavior responses with respect to age and sex of the child.

B. METHOD

1. *Subjects*

The subjects consisted of 40 preschool children who were enrolled in the preschool laboratories at Texas Woman's University. All of the children were from middle-class parents according to the McGuire-White Index of Social Status (6) (Short Form). Half of the subjects were male, and half, female ranging in age from 3 to 4-11.

2. *The Instrument*

In order to obtain measures of children's reaction to failure, a "puzzle-box test" was constructed similar to the one developed by Keister and Updegraff (5). The box was a small, lidded, colored box, 9 by 7 by 1½ inches.

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When the box was opened it was found to have a false bottom within ¼ inch from the top. On this lay 10 small, irregular-shaped, colored figures, ¼-inch thick, representing various objects of interest to children (e.g., such as a clock and a sailboat). Because of the shapes of the objects, they fitted closely into the available space. The purpose of the test was to remove the objects from the box and replace them all back in the box so that the lid could go down again. Although the test does not give an appearance of difficulty, the shapes of the objects and the size of the box make the problem a difficult one.

3. *Observations*

Observations of children were made in a laboratory setting apart from the nursery school. The laboratory was equipped with a one-way-vision mirror. Each child was brought to the laboratory for two periods. The first visit was for the purpose of acquainting the child with the laboratory. It was hoped that by means of this preliminary visit that shyness or reticence, which children might be expected to exhibit in a totally unfamiliar situation, would be at least partially overcome.

During the second visit to the laboratory the child was given the "puzzle-box test." The contents were removed from the box and the child was told to put all of the objects back into the box so that the lid could go down. An assistant remained with the child during the experiment.

The child's responses were observed and recorded every five seconds according to predetermined categories. Brief definitions and descriptions of the categories used in the investigation appear below.

a. Attempt to solve alone. E.g., child tries to solve puzzle alone.

b. Destructive behavior. E.g., child intends to harm the object or persons connected with the difficulty. Ex.: Child throws the object or pushes it off the table.

c. Directing. E.g., child specifically states the course of action which he wants the adult to follow. Ex.: "Put that part there," "Give me the red one."

d. Emotional response. E.g., child cries, yells, sulks, laughs, and whines.

e. Facial expression. E.g., child closes eyes, tightens mouth, becomes red in face, hangs out tongue, chews lips, and grinds teeth.

f. Motor manifestation. E.g., child stamps foot, moves body, clenches fist, sucks thumb, waves with hands, and pulls on ear.

g. No attempt. E.g., child makes no attempt to solve puzzle, and gives up almost at once or without exploring many of the possibilities of solution.

h. Rationalizing. E.g., child refuses to continue the solution. Ex.: "I don't want to do this," "This is a stupid puzzle."

i. Seeking attention. E.g., child calls attention to himself or his activity. Ex.: "Look what I did."

j. Seeking contact. E.g., child asks adult to come into physical contact with him. Ex.: "Come over and sit by me."

k. Seeking help. E.g., *physical*: Child asks adult to help him with some difficulty connected with the activity. Ex.: "I can't put this piece in—hold this for me." *Mental*: Child asks for ideas in trying to solve the problem. Ex.: "What can I do now?" or "How can I put this in?"

l. Seeking information. E.g., child questions in pursuit of factual knowledge. Ex.: "What kind of puzzle is this?" "What is this for?"

4. *Reliability*

Before final data collection, an agreement was reached by discussion between the observers concerning types of behavior defined by each of the behavior categories and their accurate placement within a given time interval. Reliability was measured by calculating percentages of agreement between two observers recording children's responses simultaneously and independently during the 10-minute period. Children who were not included in the study served as subjects for establishing reliability. When the observers achieved a competency in the recording of the behavior of .80 or higher between independent observations (during at least five sessions), the collection of the data for the study began. The reliability ranged from .81 to .97.

C. Results and Discussion

The frequency and per cent of behavior responses to the "puzzle-box test" are presented in Table 1. Inspection of these data indicates that the majority of children made an attempt to solve the test alone. In making an attempt to solve the test, such behaviors as emotional response, facial expression, and seeking information were most frequently observed. Although some children exhibited such behaviors as destructive behavior and motor manifestations, these behaviors had a low frequency of appearance.

These findings are consistent with the report by Keister and Updegraff (5). Their investigation had a low frequency of such behaviors as cries, whines, yells, and destructive behavior. Also, as in the present investigation, they observed that the majority of children showed interest and made an attempt to solve the problem alone.

TABLE 1
FREQUENCY AND PER CENT OF BEHAVIOR RESPONSES TO PUZZLE-BOX TEST

Behavior categories	Frequency	Per cent
Attempt to solve alone	1728	36
Destructive behavior	144	3
Directing	195	4
Emotional response	384	8
Facial expression	480	10
Motor manifestation	96	2
No attempt	189	4
Rationalizing	293	6
Seeking attention	240	5
Seeking contact	336	7
Seeking help	283	6
Seeking information	432	9

The mean number of behavior responses to the "puzzle-box test" between age groups are given in Table 2. Of the comparisons made, five behaviors were significant at the .05 level or beyond. Although more than half of the behaviors were not significant, the evidence does indicate that (*a*) the four-year-olds expressed more facial expressions and rationalizing behavior, and (*b*) the three-year-olds expressed a significantly greater number of behaviors as no attempt, seeking help, and seeking information.

TABLE 2
MEAN NUMBER OF BEHAVIOR RESPONSES TO PUZZLE-BOX TEST BETWEEN AGE GROUPS

Behavior categories	3-year-olds' ($N = 20$) mean	4-year-olds' ($N = 20$) mean	Significance level
Attempt to solve alone	42.85	43.55	
Destructive behavior	3.45	3.75	
Directing	4.75	5.00	
Emotional response	9.80	9.40	
Facial expression	9.95	14.05	.01
Motor manifestation	2.50	2.55	
No attempt	5.90	3.55	.01
Rationalizing	6.95	7.70	.05
Seeking attention	6.30	5.70	
Seeking contact	8.15	8.65	
Seeking help	7.55	6.60	.05
Seeking information	12.10	9.50	.001

The finding that there are significant differences in behavior responses between age groups in a failure situation is not in agreement with the Keister and Updegraff investigation. In a preliminary analysis, Keister and Updegraff found no statistically significant age differences. This lack of agreement may be attributed to such differences as the laboratory setting, methodology (e.g., such factors as recording behavior and categories), and sample.

In Table 3 are presented the mean number of boys' and girls' behavior responses to the "puzzle-box test." A significantly greater number of boys showed more destructive, emotional-response, facial-expression, rationalizing, and seeking-help behaviors than girls. However, girls expressed more significantly such behaviors as attempting to solve alone, seeking contact, and seeking information.

TABLE 3
MEAN NUMBER OF BOYS' AND GIRLS' BEHAVIOR RESPONSES TO PUZZLE-BOX TEST

Behavior categories	Boys' ($N = 20$) mean	Girls' ($N = 20$) mean	Significance level
Attempt to solve alone	38.95	47.45	.01
Destructive behavior	4.05	3.15	.05
Directing	4.85	4.90	
Emotional response	10.65	8.55	.01
Facial expression	13.80	10.20	.01
Motor manifestation	2.75	2.05	
No attempt	4.65	4.80	
Rationalizing	9.10	5.55	.001
Seeking attention	6.35	5.65	
Seeking contact	7.70	9.10	.01
Seeking help	7.85	6.30	.05
Seeking information	9.30	12.30	.001

Although investigations by Beaver (1), Green (2), Hattwick (3), and Jersild and Markey (4) were not designed to study children's reactions to failure, the findings did indicate that boys tend to respond more aggressively than girls to various situations. This finding seems to be in agreement with the present study, as boys evidenced significantly more negative-type behaviors than girls (e.g., destructive and emotional response). Probably the most important contribution of the present study is its indication of age and sex differences in children's responses to failure. However, further study is needed for more conclusive results, especially the observation of children's reactions to failure in the natural environment (i.e., home).

D. SUMMARY

The study was twofold: (*a*) to observe the frequency of behavior responses which a child of preschool age gives when confronted with a failure situation, and (*b*) to compare these behavior responses with respect to sex and age of the child.

The major findings were as follows:

1. The majority of children made an attempt to solve the problem alone.
2. Behavior responses such as emotional response, facial expression, and seeking information were observed most frequently.

3. At the four-year-old level, the children expressed more facial expressions and rationalizing behavior. At the three-year-old level, the children expressed a significantly greater number of behaviors as no attempt, seeking help, and seeking information.

4. Boys evidenced a significantly greater number of destructive, emotional-response, facial-expression, rationalizing, and seeking-help behaviors; while girls expressed more significantly such behaviors as attempting to solve alone, seeking contact, and seeking information.

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SEX DIFFERENCES IN TEST PERFORMANCE OF MATCHED GIRL-BOY PAIRS IN THE FIVE-TO-NINE-YEAR-OLD AGE RANGE*[1]

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A. INTRODUCTION

The present paper aims to add specific confirmation to the generally held thesis that boys, at the time of school entrance and continuing for some years thereafter, tend to be developmentally less mature than girls of the same age.

Though this belief seems to be generally held by educators, it has had little or no effect in determining actual admittance policy in the public schools. And there is little literature in which performance of matched pairs of boys and girls has been compared.

As early as 1923 (4) we find in the literature such general statements as:

> At any age, in any field of development, we find girls further along the road to their goal than boys. In other words, the girls are in every respect physically more mature than their brothers. What is the meaning of this fact for education?

In 1927, Edward A. Lincoln (7) suggests:

> If it is true, as research data indicate, that girls are in general physically more mature in every respect than boys of a corresponding age, then it follows that girls should be doing more advanced work than boys of the same age.
>
> A possible method by which girls could be given an opportunity to profit by their precocious development is the admission of girls to school at an earlier age than the boys. Thus where the legal age for entrance is now 6 years, girls could be admitted at 5 or boys could be refused admittance till 7.

Pauley has been pointing out marked sex differences in developmental level, which favor girls, for some 25 years. His most recent and largest-scale study involved 29,992 Tulsa, Oklahoma, school children attending grades 2 through 8 in 1956-57. Results of his study led him to the following recommendations (10) to the American Association of School Administrators:

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> 1. If boys are admitted 6 months or so later than girls, there will be less frustration for boys, their parents, and their teachers; and there will be fewer drop-outs of boys in high school because of failing to do satisfactory work.
>
> 2. State legislatures or boards of education should raise the legal entering age for boys.
>
> 3. All mental age norms published should provide norms for each sex separately.
>
> Data suggest that the developmental curve for post-adolescent girls flattens out somewhat and that boys begin to catch up. *But boys have not caught up* with girls by the 12th grade. . . . Girls are still 4 months ahead of boys in the second grade.

King (6), reporting in 1955 on a first-grade class of 104 children observed in Oak Ridge, Tennessee, notes that, at the end of the first year, 11 students were retained. Only one child who had entered Grade 1 *after* six years of age was retained, while 10 who entered before six years were retained. Only three of the 11 kept back were girls.

Our own as-yet-unpublished findings (5) confirm this impression that if boys and girls are entered in school at some uniform minimum entrance age, more boys than girls turn out to be unready for the grade in question. Thus in one kindergarten group of 54 cases, of 31 children who turned out at year's end to have been ready, 22 were girls, nine were boys. Of the 18 whose performance was either questionable or definitely failing, seven were girls and 16 were boys. Findings were similar in the later grades.

For most of the studies reported in the literature, group means were compared rather than the performance of carefully matched pairs of boys and girls. (This paper does not attempt to review the massive literature on sex differences in general, which has been so fully presented and summarized by Terman (12, 13) and others.)

B. SUBJECTS

Subjects for this study were children enrolled at the Hurlbutt School, Weston, Connecticut, in the fall of 1957. They then included an entire kindergarten division (81 children), one first-grade class (26 children), and one second-grade class (29 children). These subjects were tested in the fall of 1957, the spring of 1958, fall of 1958, fall of 1959.

From these subjects we matched as many girl-boy pairs as possible with relation to WISC *IQ*, age in months, and socioeconomic status. Many of the subjects selected were identical for all three measures. Discrepancies, with only a few exceptions, did not exceed four *IQ* points, four months in age, and one level of socioeconomic status as measured on the Minnesota Scale of Paternal Occupations (14).

From among the 81 kindergarten subjects, from 14 to 18 pairs at an age (28 to 36 children) could be so matched; of the 26 original first graders, six pairs or 12 subjects could be matched; of the 29 original second graders, seven to nine pairs or 14 to 18 subjects.

Table 1 gives median age, *IQ,* and SES for all groups of subjects. When subjects could not be matched identically, it was our effort to give boys the benefit of added age and *IQ,* and a higher SES.

TABLE 1
MEDIAN AGE, INTELLIGENCE, AND SOCIOECONOMIC LEVELS OF SUBJECTS AT TIME OF FIRST TESTS

	Kindergarten	First Grade	Second Grade
Number of pairs*	18	6	9
Median *IQ*			
Girls	116	111	108
Boys	117	113	109
Median SE level			
Girls	II	II	II
Boys	II	II	II
Median age in months			
Girls	67	77	84
Boys	67	76	85

* This *N* is occasionally slightly reduced because of missing records at later ages, as noted in the results for individual tests.

C. FINDINGS

Table 2 reviews major findings on all tests, scores of matched pairs of girls and boys compared. As this table and the detailed discussion of performance on separate tests which follows indicate, regardless of test used and regardless of age of subjects, for nearly every test at every age when responses of these matched pairs of girls and boys are compared, it is the scores of girls which are superior and which show greater maturity of response.

1. *Incomplete Man*

Incomplete Man responses were available for a kindergarten group of 18 girls and 18 boys; for a first-grade group of six girls and six boys; and for a second-grade group of seven girls and seven boys. All subjects were available for three successive tests one year apart, except for one kindergarten pair lost on the third test. Thus, original kindergarten subjects were also tested when they were in the first and second grades; first-grade subjects were

TABLE 2
PERCENTAGE OF MATCHED PAIRS IN WHICH EITHER GIRL OR BOY GIVES THE BETTER PERFORMANCE

	Kindergarten Test number			First grade Test number			Second grade Test number		
	1	2	3	1	2	3	1	2	3
Incomplete Man									
Number of pairs	18	18	17	6	6	6	7	7	7
Girls superior	83%	83%	76%	67%	100%	67%	71%	86%	100%
Boys superior	17%	17%	24%	33%	0	33%	29%	14%	0
Visual III									
Number of pairs	16	15	14	6	6	6	7	7	7
Girls superior	81%	53%	57%	50%	83%	83%	43%	28%	57%
Boys superior	19%	47%	43%	50%	17%	17%	57%	72%	43%
*Mosaic**									
Number of pairs	18	18	17	6	6		9	9	9
Girls superior	72%	55%	53%	50%	33%	—	66%	55%	66%
Boys superior	28%	17%	29%	12%	66%	—	33%	11%	11%
Rorschach									
Number of pairs	17			6			7		
Girls superior	53%			83%			57%		
Boys superior	47%			17%			43%		

* Not all percentages add up to 100% since performance of some pairs was judged equal.

also tested in the second and third grades; second grade subjects were also tested in the third and fourth grades.

Responses of each girl-boy pair were compared to determine which child (i.e., girl or boy) gave a superior performance for the total test (2) and, separately, for performance on hair, ear, eyes, neck, arm, and leg.

As Table 2 indicates, so far as an evaluation of the total test response for every group on every test, girls gave the superior performance for two-thirds or more of the pairs.

So far as separate parts of the man are concerned (Table 3), girls excelled for every part at every age with only the following exceptions: performance of girls and boys was equal for hair (test 1, first grade), ear (test 2, first grade), eyes (test 1, first grade), and leg (test 2, first grade). Boys did better than girls for eyes (test 1, second grade), arm (test 3, first grade), and leg (test 2, second grade).

Thus girls excelled over boys in 56 out of a possible 63 comparisons of performance on the Incomplete Man test.

TABLE 3
INCOMPLETE MAN TEST
(Percentage of pairs in which either girl or boy gives the better performance)

	All		Hair		Ear		Eyes		Neck		Arm		Leg	
	G	B	G	B	G	B	G	B	G	B	G	B	G	B
Kindergarten (N = 18 pairs)														
Test 1	83%	17%	77%	23%	77%	23%	83%	17%	72%	28%	72%	28%	77%	23%
Test 2	83	17	61	39	61	39	72	28	72	28	61	29	77	23
Test 3	77	23	77	23	77	23	70	30	82	18	59	41	52	48
First grade (N = 6 pairs)														
Test 1	66	33	50	50	83	17	50	50	83	17	66	33	66	33
Test 2	100	0	83	17	50	50	83	17	100	0	66	33	50	50
Test 3	66	33	83	17	66	33	66	33	66	33	33	66	83	17
Second grade (N = 7 pairs)														
Test 1	71	29	43	57	86	14	43	57	100	0	86	14	71	29
Test 2	86	14	71	29	71	29	86	14	86	14	57	43	43	57
Test 3	100	0	100	0	86	14	71	29	71	29	86	14	71	29

2. *Lowenfeld Mosaic Test (8)*

Mosaic designs of matched pairs of girls and boys were available for 18 pairs while these subjects were in kindergarten and again when they were in the first grade, and for 17 of these pairs in the second grade. Six first-grade pairs were also available a year later when these children were in the second grade, though the following year these tests were given at such uneven age intervals that they could not be compared. Nine pairs of original second-grade subjects were available for a succession of three yearly tests.

Comparisons of which of each pair of tests was superior—i.e., boy or girl—were made on the basis of a gradient of increasingly good responses outlined by us in Ames and Ilg, *Mosaic Patterns of American Children* (1). When two products fell at the same level of difficulty or complexity, a qualitative judgment was made as to which of the two was superior. In some instances, products of any given pair were judged as approximately equal. It is for this reason that percentages do not always add up to 100 per cent.

As Table 2 indicates, in only one group out of eight (the second test on the original first-grade group) are the products of boys judged better than those of girls. In every other set of pairs, girls showed greater maturity than boys in the majority of comparisons.

3. *Rorschach*

Rorschach responses for 17 pairs of kindergarten subjects, six pairs of first graders, and seven pairs of second graders were compared for each girl-boy pair to determine which of each pair gave the more mature response. Judgment as to greater maturity was based chiefly on higher R, lower W per cent, lower F per cent, higher F+ per cent, higher M, and higher sC.

Only the first-year's tests for each group were used, since the Rorschach did not appear as good a test as others used for making comparisons of maturity of response. The reason for this was that, though in every group of subjects tested a general global judgment could be made as to which of any given pair gave the superior performance, when the sum of specific detailed scores (Table 4) was considered, an accurate decision as to which response in any given pair was the more mature was extremely difficult to make.

Of the Rorschach paired tests considered, as Table 2 shows, for every group of subjects—especially for first graders—girls' Rorschach responses do for the group as a whole appear to be more mature than those of boys.

A detailed comparison of the several Rorschach variables is given in Table 4. Study of the details in this table suggests the difficulty of making a valid

TABLE 4
Rorschach Response

	Kindergarten (17 pairs)		First grade (6 pairs)		Second grade (7 pairs)	
	G	B	G	B	G	B
R						
Mean	12.4	12.8	11	13	14	18
Higher R in	7	7*	2	4	3	4
F%						
Mean	78%	66%	68%	76%	80%	69%
Lower F in	7	9	4	2	2	5
F+%						
Mean	85%	76%	89%	81%	90%	91%
Higher F+ in	11	4	5	1	3	4
W%						
Mean	62%	64%	69%	54%	54%	52%
Lower W% in	9	8	2	4	3	4
M						
Mean	.29	1	.66	.33	.57	.86
Higher M	1	10	2	1	3	3
FM						
Mean	.82	1.5	1.3	1.2	1	2.6
Higher FM	4	9	3	3	1	5
sC						
Mean	1	.5	.6	1.1	.6	.9
Higher sC	10	4	2	1	2	2
A%						
Mean	54%	49%	65%	56%	50%	58%
Lower A%	8	8	3	3	5	2
H%						
Mean	8%	11%	9%	9%	19%	13%
Higher H%	6	9	2	4	4	3

* For some variables some scores are equal in girls and boys.

determination of which of any single pair of girl-boy Rorschach responses was the more mature since one of the two tended to be ahead in some respects, and the other in others. Obviously there is great variability as to whether girls or boys show greater maturity from variable to variable and from age to age.

Also, human movement responses, M (which are probably more a measure of individuality than of maturity, and which for the age range in question tend to occur more frequently in boys than in girls) weigh disproportionately in determining any qualitative judgment as to superior or more mature performance.

Thus, even in this early age range, the Rorschach test is apparently too much a test of individuality to be considered an ideal measure of maturity or developmental status.

4. *Visual III*

One of the standard battery of developmental tests which has proved most useful in discriminating developmental status at other age levels (11) is Visual III, from the Monroe Reading Aptitude test (9).

As Table 2 indicates, girls give a superior performance on this test at six of the nine ages for which we have paired matched sets of girl-boy performance.

Available for comparison are 16 girl-boy pairs from the original kindergarten class (15 of these pairs are seen also in the first grade, and 14 in the second grade); six original first-grade pairs (seen also in the second and third grades); and seven original second-grade pairs (seen also in the third and fourth grades).

For the original kindergarten population, the performance of girls is ahead of that of boys for each of the three yearly tests given. For the original first-grade population, girls' performance is more mature than that of boys in two of three tests, and is equal on the third. However, with the oldest subjects (the original second graders) performance of boys is the more advanced in two of the three tests.

TABLE 5
VISUAL III
(Mean scores and mean per cent correct of those attempted)

	Test 1		Test 2		Test 3	
	G	B	G	B	G	B
	(16 pairs)		(15 pairs)		(14 pairs)	
			Kindergarten			
Mean score	6.2	4.4	6.7	5.9	9.0	7.4
Mean % correct*	58.0%	56.3%	58.5%	61.1%	62.2%	81.4%
			First grade ($N = 6$ pairs)			
Means score	6.8	6.4	10.1	8.1	10.4	8.7
Mean % correct*	62.8%	65.0%	70.6%	76.5%	71.3%	80.0%
			Second grade ($N = 7$)			
Mean score	6.2	6.7	9.1	10.1	9.9	9.3
Mean % correct*	63.4%	60.9%	72.3%	83.3%	70.7%	76.6%

* Of those tried.

Table 5 gives a more detailed analysis of performance on Visual III, giving mean scores for girls and boys on each test as well as mean percentage of those forms tried which are reproduced correctly.

As this table shows, in kindergarten subjects *for all three tests* given, girls are ahead of boys in mean scores. In first-grade subjects, girls are ahead of boys on all mean scores. However, in second-grade subjects, boys are ahead on tests 1 and 2, and girls only on test 3.

Accuracy, however, is a different matter. Though, for most tests, boys get lower mean and median scores than do girls, *in seven out of nine test groups, boys are more accurate than are girls* on both mean and median per cent correct out of those attempted. That is, boys try to reproduce fewer forms than do girls, but are more highly correct on those they do try.

However, it must be noted that the response to Visual III does not in all subjects improve steadily with age, as does the response to many of our developmental tests. Thus, for the six available matched pairs of first graders, in five of 12 subjects improvement is steady, the score on each successive test being better than that on earlier tests. However, in seven subjects progress is extremely uneven, being frequently less good on a later test than on an earlier one.

Similarly, of the 14 matched pairs of kindergarten subjects whose records were available on all three tests (28 subjects), there is steady improvement in 18 subjects, extremely variable progress in 10. In the second-grade subjects, of 14 subjects, five make steady improvement, and nine have a variable course.

In spite of this variable progress in individual subjects, the percentage of correct forms out of all those tried increases steadily with age (see Table 5), except that the original second graders fall off slightly in accuracy at nine years.

D. SUMMARY

Subjects for this paper were matched girl-boy pairs selected from 136 primary-school children from a public school in Connecticut. Eighteen pairs of kindergarten subjects, six pairs of first graders, and nine pairs of second graders were matched for age, *IQ,* and socioeconomic status of parents.

Subjects were given a battery of tests which included the Gesell Incomplete Man test, the Rorschach, the Lowenfeld Mosaic, and Monroe's Visual III. Tests were given to all subjects annually for three successive years.

Test results were compared for each pair of subjects to determine which of each girl-boy pair gave the superior or more mature response. For all tests for all three groups of subjects at nearly every age, the responses of girls were superior to those of boys. The superiority and greater maturity of the girls over the boys is seen most clearly and consistently in the Incomplete Man Test.

Present findings confirm those of earlier investigators in suggesting that the test performance of girls in the five- to nine-year-old range appears to be considerably advanced over that of boys in the same age range. These findings also support the recommendations of some educators that, since at the time of school entrance boys are developmentally slower than girls of equal age and intelligence, boys might benefit from entering school at a slightly later age than girls. It also appears that norms which define expected performance of five- to nine-year-olds should be given separately for the two sexes.

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THE RELATION OF GIVING CHILDREN AN ALLOWANCE TO CHILDREN'S MONEY KNOWLEDGE AND RESPONSIBILITY AND TO OTHER PRACTICES OF PARENTS*[1]

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A. INTRODUCTION

Marshall and Magruder (9) recently presented evidence that the practice of giving an allowance does not deserve its present prominence in recommendations for money education. They reported that knowledge of the purchasing value of money did not differ for 110 children receiving an allowance and 402 children receiving money to spend in other ways. Their study was the first research evidence on which recommendations could be based. For more than 25 years, however, parents have been advised by books and bulletins prepared for mass distribution (e.g., 1, 4, 5, 7, 10) that children who receive an allowance will learn more about money than children not given an allowance.

The contradiction between this research evidence and the extent of the recommendation suggested a need for further research on the value of an allowance. Other results of the study by Marshall and Magruder indicated factors that need control in such research. The children given allowances had been given more experience with money than other children, and were children of parents who averaged a year more of education and a higher socioeconomic status than other parents. These three factors, and two others—age and *IQ* of the child—were positively correlated with knowledge of the purchasing value of money for all 512 children. Children's experience with money correlated positively with all these factors except *IQ* of the child, and also differed with farm-nonfarm residence, number of siblings, and employment of the mother. The inference was drawn from these findings that more adequate tests of the effects of an allowance could be made if children given allowances were matched on as many as possible of these factors with children who received spending money in other ways.

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[1] The investigation reported in this paper was conducted in part in connection with a project of the Home Economics Department of the Kentucky Agricultural Experiment Station and is published with permission of the Station Director. It was written after the author was employed elsewhere.

This study tests the hypothesis that there is no difference in financial knowledge and responsibility between children given an allowance and those not given an allowance. The tests are of differences in scores on a wide variety of tests of knowledge and responsibility for matched pairs of allowance and nonallowance children. Children attending the same school, who met the allowance and nonallowance criteria, were matched on the bases of age, sex, *IQ,* socioeconomic status of family, intactness of family, number of siblings, farm and nonfarm residence, and length of attendance at that school.

Additionally, this study tests a hypothesis that parents who give their children allowances differ in other practices and in attitudes about money from parents who handle the problem of providing spending money for their children in other ways. This hypothesis derives from an assumption that parents who follow the recommendations of parent educators differ in other ways from parents of the same socioeconomic level who do not follow these recommendations. Some such hypothesis is needed to account for an inference of the previous study: allowance children should have had more knowledge of the purchasing value of money than was obtained, because they scored higher in several factors relating positively to knowledge of money than nonallowance children, as is described in the second paragraph. The tests of this hypothesis are of differences in reported practices and test scores for parents giving and not giving allowances to their children.

B. CRITERIA FOR SELECTION AND MATCHING OF SUBJECTS

During the conduct of this and the earlier study, "allowances" were found to have almost as many meanings as the number of families giving allowances to children. The definition of *receiving an allowance* presented to all children and adults participating in any aspect of this project was as follows: the child can count on receiving from parents or relatives a specified amount of money to spend on something other than the school lunch, in a specific period of time (each school day, week, etc.) each time the period recurs. Children who expected or were given by parents and relatives a different amount of money or no money to spend each day, week, or month, or who obtained most or all of their spending money from persons other than parents or relatives (such as, by a paper route, work for the farm owner, etc.) were classified as *nonallowance* children.

Additional criteria for classification as allowance and nonallowance children were based on agreement between the statements of children and parents, because disagreements occurred frequently between the two child statements and between the statements of children and parents. *Allowance* children were those (*a*) whose statements about how they received spending money during the individual interview and on the initial written information sheet were in agreement and met the definition of an allowance; and (*b*) whose parents stated during an individual interview that they gave an allowance to their child, and described both the specifications they established for the allowance and their reasons for giving an allowance. *Nonallowance* children were those (*a*) whose oral and written statements agreed in indicating that the child did not receive an allowance, and (*b*) whose parents stated during the individual interview that they did not give an allowance and that the child received spending money in other ways.

Allowance and nonallowance children from the same school were matched on the basis of tests and information sheets administered by the author and/or two faculty members of the University of Kentucky—Lucille M. Magruder and Janice G. Walton—to large groups of all 10-, 11-, and 12-year-old children attending the selected schools. In a session requiring about two hours, the children answered an information sheet and the tests mentioned below. Matching was on the following bases, in the order of importance given, and within the standards given as closely as possible.

1. Sex.
2. Chronological age at initial test period: within half a year.
3. *IQ* and mental age: within a 10-point *IQ* range and a half year of mental age on the California Test of Mental Maturity, 1957 short form for administration to grades 4 to 8 (11).
4. Socioeconomic status of the family: within two points on the Cornell Nine-Point Scale (3).

Matched pairs were permitted to differ, if needed, on one of the following four dichotomies:

5. Farm or nonfarm residence.
6. Intactness of family (living with both parents or not).
7. Number of siblings: within one sibling when three or fewer siblings, and as closely as possible when four or more siblings.
8. Length of attendance at the school: within half the number of years of possible school attendance, excluding the current year.

The author judged the adequacy of the classification of children into the allowance categories, and did all matching of allowance and nonallowance children.

C. Description of Subjects

The subjects (*S*s) were 180 children—90 given an allowance, and 90 matching children not given an allowance—and at least one parent or guardian of each child. There were 15 boys and 15 girls in each allowance classification at each of the ages of 10, 11, and 12 years. All families resided in rural areas, as defined by the 1950 census, and were of the white race.

The children attended seven county-system schools in six counties selected at random from the 28 counties in the Blue Grass region of Kentucky not furnishing *S*s for the earlier study by Marshall and Magruder (9). The *S*s were selected from 716 children, aged 10, 11, and 12 years, who completed tests (nonreaders could not complete the intelligence test) in the initial group testing of all children of those ages present in the schools on the test day. The schools in each county were selected by the County Superintendent of Schools.[2] This sample furnished enough matched pairs to fill the statistical plan of 15 children in each subgroup of an allowance-, sex-, and three-age-levels factorial design. The poorest matches for the allowance classifications were discarded in the eight subgroups in which possible *S*s exceeded 15 in number.

Allowance *S*s did not differ from nonallowance *S*s in the characteristics on which they were matched, according to the analysis of variance tests possible for most characteristics. The similar means for both groups are shown in Table 1. Additionally, the girls did not differ from the boys in these characteristics. Significant differences between age groups were limited to characteristics that increase with age, with the exception of *IQ* scores. The sample of 11-year-olds was brighter than that for the other two age levels. The 11-year group had the same mean mental age as the 12-year group, and had a year and a half to two years higher mean mental age than the 10-year group, as is shown in Table 1.

The *S*s were of a higher mean mental age, *IQ*, and socioeconomic status than the sample from which they were selected, as is shown also in Table 1. The mean scores of the matched pairs are at about the midpoint of the scales for these characteristics, while the mean scores of the school sample fall below the midpoint. The 12-year-olds in the school sample had a lower mean *IQ* score than the two younger age groups, but this difference is smaller than that found for the matched pairs.

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[2] School superintendents furnishing this assistance were the following: Bourbon County, Robert L. Goodpaster; Bracken County, W. L. Knuckles, Jr.; Carroll County, R. B. Cartmell; Fayette County, E. M. Norsworthy; Nicholas County, Raymond J. Wesley; and Washington County, J. F. McWhorter.

TABLE 1

Mean and Variation of Scores for Allowance and Nonallowance Subjects and for the Population from Which They Were Drawn in Child and Family Characteristics Controlled in Selection

Child and family characteristics	Allowance			Nonallowance			School sample			
	N	*M*	Range	*N*	*M*	Range	*N*	*M*	*SD*	Range
Chronological age in months										
10 years	30	126		30	126		233	126	3.6	
11 years	30	137		30	137		239	138	3.3	
12 years	30	148		30	149		244	150	3.4	
Total	90	137	120–155	90	137	120–156	716	138	10.4	120–156
Mental age in months										
10 years	30	128		30	128		233	122	19.9	
11 years	30	145		30	147		239	134	21.1	
12 years	30	145		30	146		244	140	21.9	
Total	90	139	82.5–187.5	90	140	85–199	716	132	22.1	80–199
Intelligence quotient										
10 years	30	101		30	101		233	97	15.3	
11 years	30	106		30	107		239	97	15.0	
12 years	30	98		30	98		244	93	14.7	
Total	90	102	68–148	90	102	69–140	716	96	14.6	59–148
Socioeconomic status	90	4.4	0–9	90	4.2	0–9	716	3.5	2.4	0–9
Number of siblings	90	2.4	0–15	90	2.9	0–10	716	3.6	2.8	0–16
Years attendance at that school	90	4.1	0–7	90	4.3	0–7	716	3.9	2.1	0–7

The ranges of scores listed in Table 1 for the matched pairs and the school sample are about as wide as is possible. Extreme diversity of socioeconomic status of families and of intelligence-test scores of children would not be predicted from everyday assumptions about the types of families giving allowances to children. These data indicate clearly that the practice of giving an allowance was not limited to higher-status families in this extremely diverse population.

All data were collected between January, 1959, and April, 1960.

D. DESCRIPTION OF MEASURES

Comparisons of allowance and nonallowance samples were made for measures that were obtained in four test or interview situations for each child and his parent.

The initial large-group-test situation furnished four measures:

1. Score on the financial-knowledge test: a test of 13 multiple-choice questions developed for this study, and standardized on the school sample. Questions were concerned with knowledge of insurance and mortgages, with the relative costs of items of food, clothing, and cars, and with knowledge of money management.

2 and 3. Score and percentile rank on the numerical reasoning sections of the California Test of Mental Maturity (11).

4. Information-sheet amount of money: the amount of money (excluding lunch money) the child had to spend in the past week.

Individual interviews with the children furnished six measures. Three hundred and twenty-five children, or 148 boys and 177 girls, were given individual interviews at school between the eighth and 38th day after the initial testing. These were the approximately 45 per cent of the children in each school selected for further study by the initial matching of possible allowance and nonallowance children. Interviewers were the three staff members mentioned earlier, and one graduate assistant—Hazel M. McCrary. During the 15-to-30-minute interview, the children were asked questions and given tests to furnish the following measures:

5. Coin test of knowledge of money use (9). Questions ask what the five coins under a dollar will purchase, and the child to price 18 items purchased at a dime store.

6. Experience with money score (9). A high score indicates the child has had many different experiences using money, and a low score that the child has had relatively few experiences using money.

7. Child-interview amount of money: the amount of money (excluding lunch money) the child had to spend in the past week.

8. Past-week's earned money: the amount of money the child earned in the past week.

9. Total gift and earned money received in the past year (9).

10. Number of spending classifications that the child's spending money must cover, or the number of 14 possible categories (food snacks, school needs, tickets, clothing items, club dues, gifts, etc.) the child said he must purchase from money given to him to spend, without requesting additional funds from parents.

Tests administered by teachers or principals[3] to classes or selected small groups furnished three measures. Additional selection, based on the agreement of child statements, had occurred in most schools by the time these tests were given (about a month after the initial testing). The tests were administered to 285 children—129 boys and 156 girls—and furnished the following measures:

11. Score on the Children's Manifest Anxiety Scale (CMAS) (2).

12. Score on the Lie Scale included in the CMAS: a measure of irresponsibility.

13. Score on the Harris Social Attitude Scale, "reflecting behavior classifiable as reliable, accountable, loyal, or doing an effective job" (6, p. 322).

The parent interviews furnished measures of both child and parent behavior. Parents were interviewed at home during the two months following the child interviews at each school. Interviewers were principals, counselors, and teachers (full time, substitute, or retired) at the selected schools.[4] Five measures from the parent interviews replicate those listed as Nos. 6 to 10 from the child interviews, with the exceptions noted in the listing that follows:

14. Score on parent's report of the child's experience with money. The parent's report did not include description of the child's use of money in the

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[3] Group tests were administered by the following persons in the schools: Athens School, James E. Ingle; Bracken County School, Mrs. Virgie M. Basse, Mrs. Callena M. Jett, Mrs. Cleo Knuckles, Lucille Moore, Mrs. Ben T. Rice, Mrs. George Taylor, and Mrs. Chloie F. Willman; Ghent School, Mrs. Charlene McPherson; Millersburg School, George Stewart; Moorefield School, Mrs. Howard Irvin; Russell Cave School, Vernon Calhoun; and Willisburg School, Mary Jo Hughes.

[4] The following persons conducted parent interviews in the six counties: Bourbon County, Mrs. Malcolm McCulloch; Bracken County, Mrs. Virgie M. Basse, Mrs. Callena M. Jett, Lucile Moore, and Mrs. George Taylor; Carroll County, Mrs. Rita Bond; Fayette County, Vernon Calhoun, James E. Ingle, and James Yonts; Nicholas County, Mrs. Bess Bromagen; and Washington County, Mrs. Dorval Ruby.

past week, or of the child's possible purchase of movie tickets. In comparisons of child and parent scores, points for these items were omitted from the child's score.

15. Parent report of amount of spending money: the amount of money (exclusive of lunch money) the child had to spend in the past week.

16. Parent report of the money earned by the child during the past week.

17. Parent report of the total gift and earned money received by the child in the past year.

18. Parent report of the number of spending classifications the child must pay for from spending money.

Four other measures of parent behavior were obtained from the parent interviews.

19. Parent's estimate of child's financial responsibility, developed for this project. The parent checked one of five possible questions comparing this child to (*a*) siblings and (*b*) children in his school class. The two comparisons were made for three characteristics: (*a*) thrift, (*b*) reliability, and (*c*) amount of money handled. Five points were given to a check of the "most responsible" answer, four points to "more," three points to "about the same," two points to "less," and one point to "least." Scores had a possible range from 6 to 30 points. Three points were automatically credited for sibling questions when there were no siblings.

20. Parent's estimate of child's work responsibility, developed for this project. Questions and scoring were similar to those described for financial responsibility, allowing for different adjectives. Parents judged the frequency of (*a*) home-chore reminders, (*b*) checking to see how well the child performed tasks, (*c*) the "redoing" of assigned tasks, and (*d*) the child's absence from assigned chores. Parents also compared the work responsibility of the child to that of siblings and members of the child's school class. The possible range of scores was from 6 to 30 points.

21. Parent's estimate of responsibility: the sum of the two scores just described.

22. Score on tests for money-centered attitudes (9). A high score on this test indicates that the parent agreed with statements that money is very important in life.

Six difference scores were obtained from the measures replicated in different test and interview situations. Additionally, the three reports of the amount of a week's spending money were summed to furnish a measure.

Both children and parents were asked questions about aspects of money experiences that lacked quantifiable answers. For some of these aspects, chi-square tests of differences were possible, as will be reported.

E. RESULTS

Tests of first hypothesis: There is no difference in financial knowledge and responsibility between children given an allowance and those not given an allowance.

This hypothesis was given complete support by the findings for the matched pairs of this investigation, as is shown in Table 2. Mean scores for the allowance and nonallowance *S*s did not differ on any of the 10 measures of financial knowledge and responsibility by analysis-of-variance tests. The 10 measures included six tests standardized on other groups—Nos. 2, 3, 4, 5, 9, and 10—as well as four estimates developed for this investigation—Nos. 1, 6, 7, and 8. These results for samples matched in pertinent characteristics confirm the earlier finding of no difference by Marshall and Magruder (9). They also furnish strong evidence of inaccuracy for assumptions that children given allowances will learn more about money and show more responsible behavior than children not given allowances.

Slightly more than half of the allowance parents stated that they gave an allowance in order to help their child learn financial knowledge and responsibility, as is shown in Table 3. Neither their belief nor the practice contributed to such learning, as has been described. The reasons given by the remaining 45 per cent of the allowance parents may be less socially acceptable (to adults who know of the recommendations), but these reasons suggest that giving an allowance may be a relatively easy or frictionless way to handle children's spending money for many parents.

Reasons given by nonallowance parents for their statements that they would or would not give an allowance if the child should request it are shown in Table 4. In general, these reasons suggest that nonallowance parents saw no benefit in an allowance for their child. Most parents who would give an allowance stated that their child already had the knowledge and responsibility required to handle it wisely. Among the parents who would not give an allowance, a large number gave an excuse the matching allowance parents would not have considered adequate: that they lacked the income needed to give an allowance to their child. Even more parents (30 per cent) gave specific reasons why they considered an allowance to be a poor learning experience for their child.

The significant age and sex of child differences in scores indicated in Table

TABLE 3

NUMBER AND PERCENTAGE OF 90 ALLOWANCE PARENTS CHECKING DIFFERENT REASONS FOR GIVING AN ALLOWANCE

Reason	Number	Per cent
1. To help child learn responsibility, the value of, or wise spending of money	50	55
2. Child needs, deserves, or likes an allowance	13	14
3. To give child freedom in spending money	12	13
4. Just do it	8	9
5. To help child learn to save	4	4
6. Convenience	2	2
7. To help child be like others	1	1

TABLE 4

NUMBER AND PERCENTAGE OF 90 NONALLOWANCE PARENTS WHO WOULD AND WOULD NOT GIVE AN ALLOWANCE IF CHILD SO REQUESTED, AND CHECKING DIFFERENT REASONS

Decision and reasons	Number	Per cent
1. Would give allowance if child so requested, because:	29	32
a. Child could handle it	21	23
b. Would help child be like others	3	3
c. Don't know why	5	5
2. Would not give allowance if child so requested, because:		
a. Family income too low to afford it	20	22
b. Amount given is parents' decision	14	15
c. Child lacks experience in handling money	8	9
d. Couldn't meet variation in child's needs	5	5
e. Tried it, and child wasted money	1	1
f. Don't know why, or don't know of good reasons for an allowance	13	14

2 are in the directions found in reports of the standardization of the tests, with one exception. The exception is that the present study did not replicate the age difference between 11- and 12-year-olds on the coin test of knowledge of money use reported by Marshall and Magruder (9). This failure may relate to the similarity in mental age of the 11- and 12-year-olds of these samples. In the triple interaction for the Lie Scale indicated in Table 2, allowance boys and nonallowance girls lacked the consistent decrease in number of lies that was found with each year of increasing age for allowance girls and nonallowance boys.

Tests of second hypothesis: *Parents who give their children allowances differ in other practices and in attitudes about money from parents who handle the problem of providing spending money for their children in other ways.*

Parents giving and not giving allowances differed in several other money-education practices. The mean scores on the quantifiable estimates of practices, shown in Table 5, indicate the three differences that follow.

1. Allowance parents provided their children with a wider variety of experiences in the use of money than nonallowance parents. Mean experience with money scores from both child and parent reports differed significantly for the matched pairs. This finding agrees with that reported by Marshall and Magruder (9).

2. Allowance parents made the purposes of spending money clearer to their children than nonallowance parents. There was more agreement on the specific classifications to be covered by spending money between allowance children and their parents than between nonallowance children and their parents. Allowance children also reported more spending classifications to be covered by their spending money than were reported by nonallowance children. This difference in the clarity of the purposes of spending money was not found for parent reports, however, as is indicated in Table 5. Parents of allowance boys listed more classifications as age increased, parents of allowance girls and nonallowance boys listed fewer classifications for 11-year-olds than for 10- or 12-year-olds, and parents of nonallowance girls listed more classifications for 11-year-olds than for the other two ages (the triple interaction).

3. Nonallowance parents reported that their children received about half as much spending money in the past week as allowance parents. There were no differences in the two child reports of the past-week's spending money or in any other reports about amounts of money received by the child. The difference in parent reports, than, may indicate a difference in belief or hope, rather than a difference in practice.

One difference was significant in chi-square tests of the number of allowance and nonallowance children and parents reporting other specific practices. The proportion of allowance children earning money in the past week was larger than the proportion of nonallowance children who earned money in the past week by both child and parent reports, as is shown in Table 6. Other data suggest the difference occurred for the proportion of children earning money away from home, rather than at home. There was no difference by chi-square test in the number of allowance and nonallowance parents paying for work performed by the child at home. Slightly more than half the parents in both groups made such payment, as is shown in Table 7.

These differences indicate that parents who gave an allowance differed in four other money-education practices or attitudes from parents who handled

TABLE 5

MEAN SCORES AND STANDARD DEVIATIONS OF 90 ALLOWANCE AND 90 NONALLOWANCE CHILDREN ON MEASURES OF CHILDREN'S EXPERIENCE WITH MONEY AND OF PARENT MONEY-EDUCATION PRACTICES

Measures	Mean scores		SD[a]	Significance of difference by analysis-of-variance test
	Allowance	Nonallowance		
1. Experience with money scores				
a. Child report	15.6	14.2	3.1	.005
b. Child, corrected to parent	12.2	11.2	2.6	.005
c. Parent report	12.0	10.6	3.1	.005[b]
d. Differences (b — c)	0.3	0.5	3.4	NS
2. Number of spending classifications				
a. Child report	5.2	4.4	2.6	.05
b. Parent report	4.1	3.7	2.0	(triple interaction)
c. Number of agreements between child and parent	2.6	2.2	1.4	.05
3. Parent money-centered-attitudes test	23.5	23.2	6.4	NS
4. Amount of spending money in past week				
a. Child information sheet	$ 0.89	$ 1.20	$1.70	NS
b. Child interview	0.81	0.56	1.15	NS[b]
c. Parent interview	$ 0.81	$ 0.38	$0.81	.001[b]
d. Sum of three reports	2.52	2.12	2.66	NS[b]
e. Mean difference of three reports	0.57	0.79	1.07	NS[b]
5. Amount earned in past week				
a. Child report	$ 0.42	$ 0.32	$0.65	NS
b. Parent report	0.34	0.20	0.66	(allowance-sex interaction)
c. Difference (a — b)	0.07	0.21	0.10	NS
6. Total gift and earned money of past year				
a. Child report	$38.60	$41.04	$1.79	NS[c]
b. Parent report	30.20	30.50	1.87	NS[c]
c. Difference (a — b)	10.02	10.87	2.11	NS
7. Amount earned in past year				
a. Child report	$33.14	$36.65	$1.75	NS[c]
b. Parent report	24.85	25.68	1.82	NS[c]
c. Difference (a — b)	9.98	11.27	2.04	NS

[a] The standard deviation was obtained from the MS_w of the analysis of variance, as described by Lindquist (8).

[b] Differences between age levels were significant for this measure.

[c] Sex differences were significant for this measure.

TABLE 6
NUMBER OF ALLOWANCE AND NONALLOWANCE CHILDREN AND PARENTS WHO STATED THE CHILD HAD OR HAD NOT EARNED MONEY IN THE PAST WEEK

Statement	Allowance	Nonallowance	Significance of difference by χ^2 test
Child report			
Yes	61	39	.001
No	29	51	
Parent report			
Yes	31	18	.05
No	59	72	

TABLE 7
NUMBER AND PERCENTAGE OF PARENTS OF 180 CHILDREN WHO REPORTED OTHER SPECIFIC PRACTICES AND EXPERIENCES

Practice or experience	Number	Per cent
1. Ask child to tell how he spent money		
Yes	41	23
No	139	77
2. Child tells parent how he spent money as frequently as:		
Everyday	69	38
Two or three times a week	25	14
Once a week	47	26
Once every two weeks or month	14	8
Rarely or never	25	14
3. If had larger family income,		
Would give more spending money to child	80	44
Would not give more spending money to child	100	56
4. Decisions on payment for child's work at home based on:		
Number of jobs performed	19	11
Kind of work	49	27
Daily performance of work	32	19
Not paid for work at home	80	44
5. Persons deciding amount of payment for work at home are:		
Mother and/or father	30	17
Child	40	22
Both child and parent	30	17
Not paid for work at home	80	44

the problem of providing spending money in other ways, and so support the hypothesis.

It was not hypothesized that this dichtomy of parents would differ in all practices, and they did not do so. Allowance parents did not differ from nonallowance parents in attitudes about the importance of money. As is shown also in Table 5, similarities of practice were found in the amount of money given for any purpose, and in the amount of money earned by the children at home and elsewhere. By chi-square tests, there were no differences in the number of parents in either group reporting the practices in the categories listed in Table 7. The majority of parents in both groups stated that they did not ask the child to tell how he spent his money, and that the child voluntarily told them how he spent money at least as frequently as once a week. Parents in both groups were almost equally split as to whether or not they would give the child more spending money if the family income were larger.

Sex-of-child differences were found for all measures that included an estimate of the amount of money earned in the past year. Boys reported that they earned a mean of $46.36 in the past year, while for girls the mean amount earned was $23.46. Sex and age-of-child differences were not significant in chi-square tests for the categories listed in both Table 6 and Table 7.

F. Discussion

This investigation was a controlled, matched-group study conducted to test an earlier finding on an unselected sample that contradicted a widely published recommendation. The evidence from a wide variety of tests for the matched pairs of this investigation clearly demonstrates that children given allowances do not have more financial knowledge or show more responsible behavior than children not given allowances. Recommendations that allowances help children to gain financial knowledge and responsibility have been made for 25 years and, supposedly, have been "tested through widespread practice" during this period. Hence, this study not only demonstrates inaccuracy for the recommendation, but also implies that the casual reports used to justify the continuance of the recommendation were either biassed or inaccurate.

The evidence of this study about opinions of parents suggests that the allowance recommendation did not reflect parents' experience. Only a fourth of the parents of this study indicated a belief in the cause and effect of the recommendation. Half of the parents giving an allowance, and most of the parents not giving an allowance, lacked this belief. An inference possible from these results is that casual reports of benefits from specific methods of child guidance furnish inadequate bases for recommendations to practice these methods.

Allowance and nonallowance parents differed in several money-education practices and attitudes, although their children did not differ in financial knowledge and responsibility. It can be assumed, then, that these practices and attitudes were not those causing differences in children's financial knowledge and responsibility. Analyses of parent differences were made to test the assumption that parents who follow the recommendations of parent educators differ in other ways from parents of the same socioeconomic level who do not follow these recommendations. The evidence supported this assumption, and indicated it was not an important cause of differences in children's behavior.

Since the publication of the earlier study, advocates of the allowance recommendation have suggested to the author that beneficial effects for giving children allowances appear in adolescent and adult years. The subjects of this and the earlier investigation were children aged seven to 12 years. The findings for these children, of course, cannot be generalized to the adolescent years. The inferences drawn in the preceding paragraphs, however, suggest that research evidence should precede the advocacy of such a recommendation.

G. Summary

Ninety children given allowances were matched with 90 children not given allowances on the bases of sex, age from 10 to 12 years, *IQ*, socioeconomic status of the family, farm or nonfarm residence, intactness of family, number of siblings, and length of attendance at their school. *S*s in both groups were distributed over a wide range of both *IQ* scores and socioeconomic status.

Tests and interviews of both children and their parents furnished evidence that supported two hypotheses.

1. There is no difference in financial knowledge and responsibility between children given an allowance and those not given an allowance. (Allowance and nonallowance children did not differ in mean scores on any of the ten measures of financial knowledge and responsibility.)

2. Parents who give their children allowances differ in other practices and in attitudes about money from parents who handle the problem of providing spending money for their children in other ways.

Allowance parents differed from nonallowance parents in (*a*) providing their children with a wider variety of experiences in the use of money, (*b*) making the purposes of spending money clearer to their children, (*c*) stating that their children received more spending money, and (*d*) permitting or encouraging their children to earn money away from home. The two groups of parents did not differ in other money-education practices and attitudes.

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PARENTS' ATTITUDES AND BEHAVIORS AND GRADE-SCHOOL CHILDREN'S ACADEMIC ACHIEVEMENTS*

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A. PROBLEM

Since the time of Binet's pioneering attempts to predict children's academic achievements from their performances on intelligence tests, psychologists and educators have been concerned with factors producing individual differences in young children's scholastic attainments. Early research addressed to this question was primarily devoted to the role which general intellectual abilities played in academic performances. More recently, educational and child-development researchers have concerned themselves with factors other than ability which might also contribute to performance differences. Personality variables such as achievement motivation and anxiety have been brought into the picture. The achievement need has been the center of recent concerted research efforts by a number of investigators: e.g., McClelland and his colleagues (1, 6). So, too, has anxiety been used as a predictor variable for intellectual and academic performances: e.g., McCandless and Castaneda (5); Sarason, Davidson, Lighthall, Waite, and Ruebush (7).

Research on determinants of such achievement performances has indicated that both ability and motivational variables are useful and necessary predictors. Another broad, and basic, question still remains: What are the *antecedents* of differences in children's intellectual achievement motivations and performances? In other words, what environmental factors in children's everyday experiences facilitate or impede the development of intellectual and academic competence? Many persons and situations influence a child's personality development. Parents, teachers, siblings, and peers all interact with a child in the course of his daily experiences, and each of these individuals can be an important social reinforcer of the child's behaviors. This is true whether the area of personality under consideration is the development of aggressive, dependent, affiliative, or achievement behaviors.

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Concerning the development of achievement motivations and behaviors, it is apparent to the careful observer that most children have developed, by the time they enter grade school, fairly consistent differences in the values they attach to intellectual and academic achievements, in their expectations of success in these activities, in the standards they use to judge their efforts, and in the methods and strategies they employ in their attempts to attain achievement goals. What factors produce these differences? This is the general question to which this research is directed. The present article describes one study of a larger research project concerned with parents as identification models and reinforcers of young children's achievement behaviors.[1] The investigation explored relationships between parents' attitudes and behaviors and their early-grade-school-age children's academic performances.

B. Methods

1. *Sample*

The sample was comprised of 120 *S*s: 40 early-grade-school-age children, and their fathers and mothers. The child sample contained 20 boys and 20 girls equally distributed in the second, third and fourth grades at the time the children were administered academic-achievement tests. The socioeconomic status of the families was assessed by Hollingshead's Two Factor Index of Social Position (4). The proportions of families in Hollingshead's social classifications I through V were 10, 30, 29, 31 and zero respectively, indicating that all but the lowest social classification was reasonably represented. Slightly more than one-half of the fathers and one-fourth of the mothers were college graduates. Table 1 presents information regarding the intellectual levels and academic-achievement test performances of the children. The children's intellectual abilities were assessed with the Stanford-Binet Intelligence Test; their academic performances, with the California Achievement Test.[2] As indicated in Table 1, the children of the study were intellectually superior to national norms; all but two had *IQ*s above 100, and approximately three-fourths of the children obtained scores more than one standard deviation above the national average. The mean *IQ* of the group was 124. Intellectual abilities within the sample, however, varied appreciably. The children's *IQ*s ranged from 79 to 164, with a *SD* of 16. As might be expected from their intelligence-test scores, the children's performances on

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[1] This study was a part of the project "Parents as identification models and reinforcers of children's achievement development," partially supported by USPH Grant M-2238, awarded the first-listed author.

[2] The second author of this report administered the academic-achievement tests. Appreciation is expressed to Dr. Virginia Nelson, who gave the Stanford-Binet Intelligence Tests to the children.

TABLE 1
INTELLIGENCE AND ACADEMIC-ACHIEVEMENT-TEST PERFORMANCES OF THE CHILDREN

	Number of children
Stanford-Binet *IQ*	
Below 100	2
100-114	9
115-129	13
130-144	14
145 and over	2
Reading age *vs.* chronological age	
RA less than CA	2
RA 1-9 months beyond CA	7
RA 10-19 months beyond CA	19
RA 20-29 months beyond CA	5
RA 30-39 months beyond CA	4
RA 40-49 months beyond CA	2
Arithmetic age *vs.* chronological age	
AA less than CA	5
AA 1-9 months beyond CA	12
AA 10-19 months beyond CA	13
AA 20-29 months beyond CA	7
AA 30-39 months beyond CA	3

the standard academic-achievement tests were generally above grade level. Only two of the children were reading below grade level, and only five were not performing at or above their grade level in arithmetic.

2. *Assessment of Parent Attitudes and Behaviors*

The parents were interviewed individually at the Fels Research Institute for the Study of Human Development. To prevent communication between parents, each set of parents was interviewed concurrently but separately.[3] The interview sessions averaged from two-and-one-half to three hours, and were electronically recorded for subsequent interview analyses. Two interviews were given each parent during the interview session. The first was concerned with the parent's attitudes and reported behaviors toward his child's everyday achievement efforts. This interview covered four achievement areas, only one of which—the intellectual achievement area—is relevant to the present study. The second interview covered several general (nonspecific to achievement) behaviors of the parents. These included parental affection, rejection and nurturance.[4] Copies of the parent interview schedules and rating scales may be obtained.[5]

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[3] The fathers were interviewed by the third-listed author; the mothers, by the fourth author.

[4] A fourth general parental-behavior variable—dominance—was also assessed in Interview II for a study other than the present one, and is not discussed in this report.

[5] Virginia Crandall, Fels Research Institute.

3. *First Interview*

Interview I obtained information regarding the following parental attitudinal and behavioral variables:

a. The parent's attainment value for his child's intellectual performances. This referred to the degree of importance or value the parent attached to his child's intellectual achievements. This rating assessed the intensity of the parent's desire that his child show interest and participate in intellectual activities; and the value the parent placed on his child's effort, persistence, and competence in these situations.

b. The parent's evaluation of his child's intellectual competence. This variable was concerned with the level of competence the parent felt his child characteristically demonstrated in intellectual activities.

c. The parent's satisfaction-dissatisfaction with his child's intellectual-achievement performances. Ratings of this variable focused on the amount of satisfaction *vs.* dissatisfaction the parent expressed regarding his child's intellectual-achievement performances. This rating was exclusively concerned with relevant parental feelings as these were expressed to the interviewer; the parent's reported overt reactions (praise, criticism, etc.) to his child's efforts were *not* a part of the rating.

d. The parent's minimal standards for his child's intellectual achievement performances. Here the "personal yardstick" the parent used to judge his child's intellectual performances was considered. The major judgment for this rating entailed the determination of the minimal level of intellectual competence below which the child's performance produced parental dissatisfaction and above which the parent felt more satisfied than dissatisfied with his child's efforts.

e. Parental instigation of intellectual activities. This (like the remaining variables of Interview I) was concerned with reported parental behaviors rather than parental attitudes. Parental instigation referred to the frequency and intensity of the parent's attempts to increase his child's participation and competence in intellectual activities. The parent's reactions to his child's efforts *after* he had performed were not included here. To be a relevant behavioral referent for this variable, the parent's behavior must have preceded some activity on the part of his child. Examples of instigation included such events as the parent arranging for his child to receive special lessons or experiences in some intellectual pursuit, the parent making a special effort to convey to his child the importance of intellectual experiences, and the parent encouraging and/or demanding that his child participate in intellectual-achievement activities.

f. The parent's participation with his child in intellectual-achievement activities. This variable pertained to the extent that the parent actively engaged in intellectual-achievement pursuits with his child. Both the frequency of parental participation and the amount of personal involvement while so engaged constituted rating referents for this variable.

g. Positive parental reactions. Here the frequency and intensity of the parent's positive reactions to his child's intellectual-achievement behaviors were assessed. These included the degree to which the parent responded favorably to his child's interest and participation in intellectual-achievement activities, as well as the parent's positive reactions to the effort and the competence his child exhibited in these pursuits. Positive parental reactions might take the form of direct verbal approval or other less-direct symbols of approbation, such as granting special privileges or giving rewards (e.g., money, gifts, etc.) for intellectual achievements.

h. Negative parental reactions. This variable was concerned with the frequency and intensity of disapproval and criticism which the parent expressed to his child for any lack of interest, participation, effort and/or competence in intellectual-achievement activities.

4. *Second Interview*

Interview II sampled the parents' reported behaviors with their children which were nonspecific to the children's intellectual-achievement performances, but were aspects of parent-child interaction which might possibly influence (either directly or indirectly) children's intellectual-achievement efforts. The variables rated were:

a. Parental affection. This variable pertained to the amount of overt affection and acceptance which the parent reported expressing toward his child.

b. Parental rejection. Here the raters focused on the degree that the parent directly expressed dissatisfaction with, was critical of, or punitive about, his child's general personality attributes or characteristic behaviors.

c. Parental nurturance. The behavioral referents for this rating were those relevent to the frequency and quality of emotional support and instrumental help given the child by the parent.

5. *Rating Procedures and Methods of Data Analysis*

The criterion rater for Parent Interview I rated all interviews of the 80 parents from typescripts of the interviews. Reliability raters rated 40 randomly picked father and mother interviews. All identifying information (e.g., parent, child, and sibling names, etc.) was removed before the interview protocols were rated. Interview II was rated after the rater listened to the interview recordings.[5] It was felt that, while the data in Interview I was concerned with specific parental attitudes and behaviors which could be assessed from typescripts, Interview II data included important parental feelings and expressions which were less likely to be represented accurately in typed protocols. For example, in Interview II, two fathers (or mothers) might say that their children were "little hellions" in certain situations; yet one parent might mean (and convey) that he thoroughly disapproved of this behavior, while a second parent might make the same statement, but indicate (through his intonation) that he actually approved of these behaviors on the part of his child.

The children's academic-achievement-test scores used in the study were achievement-ratio scores; the reading-achievement score for each child was his reading age divided by his chronological age, and his arithmetic score was obtained by dividing his arithmetic age by his chronological age.

Statistical analyses employed in the study were exclusively nonparametric tests. The rank-difference correlation was used for all measures of association, and Wilcoxon's Unpaired Replicates Test was employed for all assessments of differences (8).

C. Results and Discussion

1. *Interrater Reliabilities*

The interrater reliability coefficients for Parent Interview I are presented in Table 2. The magnitude of rater concordance for these variables, with one noticeable exception (the mothers' reported negative reactions), ranged from moderately acceptable to highly acceptable agreement. Interrater reliabilities of the mother interviews of Parent Interview II were, for the variables of affection, rejection, and nurturance respectively, .87, .61 and .68. Correlations of interrater agreement for the same variables in the father interviews were .76, .85 and .78.

2. *The Child Variables*

Relations between the children's *IQ*s and their scholastic-achievement-test performances were assessed. Intelligence-test scores correlated .57 and .59

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[5] The criterion rater for Parent Interview I was the senior author. The reliability raters for this interview were the third author, for the mother interviews; and the fourth author, for the father interviews. The criterion rater of Parent Interview II was Virginia Crandall. The reliability ratings (made from 40 randomly selected father and mother interviews) were done by the fourth author and the third author respectively.

TABLE 2
INTERRATER RELIABILITIES FOR PARENT INTERVIEW I (PARENT ATTITUDES AND REPORTED BEHAVIORS TOWARD THE CHILDREN'S INTELLECTUAL-ACHIEVEMENT EFFORTS)

Parent variable	Re. mothers	Re. fathers
Attainment value	.50	.80
Evaluation of competence	.78	.94
Satisfaction-dissatisfaction	.85	.96
Achievement standards	.63	.57
Instigation	.63	.76
Participation	.70	.84
Positive reactions	.86	.80
Negative reactions	.22	.79

with reading and arithmetic-achievement-test scores respectively for the girls, and .66 and .50 for the boys. These correlations are similar in magnitude to associations found in previous studies of children's intelligence and their performances on standard academic-achievement tests. These data indicate, as have the results of previous investigations, that general intelligence is one major factor in children's academic achievements. However, the fact that less than one-third of the variance was held in common by these sets of variables (i.e., intelligence- and achievement-test performance) suggests that other factors may also be influential. Parents' attitudes and behaviors influencing children's intellectual-achievement motivations and behaviors may account for some of this variance.

3. *Relations Between General Parental Behaviors and Children's Academic-Achievement-Test Performances*

Associations between general parental behaviors (i.e., affection, rejection, and nurturance) and the children's reading- and arithmetic-test performances were evaluated separately by sex of parent and sex of child. Of the 24 correlations run, only three were significant beyond the .05 level of confidence according to Old's Tables (8). This is only slightly better than might be anticipated by chance. That the significant correlations obtained were probably not chance occurrences, however, is suggested by the fact that all significant associations pertained *only* to the mothers and their daughters. Girls who were competent readers had both less affectionate and less nurturant mothers than did the girls who demonstrated less proficiency in that academic area; correlations between the girls' reading-achievement-test scores and their mothers' affection and nurturance were —.38 and —.43 respectively. In addition, girls who performed better on the arithmetic-achievement test had mothers who were also relatively low on nurturance; the Rho obtained was —.45.

Why should low maternal nurturance and affection seem to foster academic competence in the girls? Several possibilities are likely. First, the affectionate and nurturant mothers, by rewarding their daughters' affection-seeking and dependent behaviors, may have "taught" these girls to expect such overtures to be more effective means of attaining personal security than behaviors requiring independent initiative and achievement striving. In contrast, girls who did not receive as much maternal affection and support, might have turned to other potential sources of satisfaction and security, such as achievement *per se*. Second, previous research has demonstrated that maternal nurturance fosters children's dependence and impedes the development of independence and achievement behaviors (3, 9). Restrictions of learning experiences in independence and achievement in the more highly nurtured girls of the present study may have produced (*a*) fewer possibilities for developing independent problem-solving techniques to handle achievement situations, and (*b*) less confidence (and more anxiety) regarding abilities to do so. One final explanation for the negative relations obtained between maternal nurturance and affection and the girls' academic achievements pertains to young girls' attempted identification with, and emulation of, their mothers. All parents act as learning models for, as well as direct reinforcers of, their children's behaviors. The mother who readily proffers love and help to her child may derive personal satisfaction from such maternal behaviors, and may serve as a model to her daughter to this effect. On the other hand, the mother who withholds affection or rejects her child's help-seeking and emotional support-seeking may be less involved with the maternal role and be more achievement-oriented. Consequently, her daughter is, to the degree she uses her mother as an identification model, more likely to emulate her mother's achievement behaviors, values and motivations, and to attempt to become competent in academic achievement situations.

4. *Relations Between Parents' Specific Attitudes and Behaviors Toward Children's Intellectual Achievement Efforts and Children's Performances on Standard Achievement Tests*

Data relevant to this portion of the study are summarized in Tables 3 and 4. The first four parent variables listed in these tables are attitudinal variables; the last four are behavioral variables. Each will be discussed in turn.

a. Attitudinal variables. The *attainment values* the parents placed on their children's intellectual competence were essentially unrelated to their children's academic-achievement-test performances. In fact, the only significant correla-

TABLE 3
PARENTS' ATTITUDES AND ACTIONS AND CHILDREN'S READING ACHIEVEMENT*

Parent variable	Mothers re.		Fathers re.	
	Girls	Boys	Girls	Boys
Attainment value	—.14	.35	*—.38*	.03
Evaluations	*.44*	*.48*	.28	.21
Satisfaction-dissatisfaction	*.51*	*.48*	*.38*	.23
Standards	*.48*	.18	.15	.26
Instigation	*—.52*	.18	*—.43*	—.07
Participation	—.10	.06	—.28	—.25
Positive reactions	—.11	.09	*.42*	—.17
Negative reactions	—.27	—.18	*—.45*	.06

* Italicized correlations are significant at or beyond the .05 level of confidence (one-tailed test).

TABLE 4
PARENTS' ATTITUDES AND ACTIONS AND CHILDREN'S ARITHMETIC ACHIEVEMENT*

Parent variable	Mothers re.		Fathers re.	
	Girls	Boys	Girls	Boys
Attainment value	.17	.23	—.26	—.05
Evaluations	.23	.35	.20	.04
Satisfaction-dissatisfaction	*.76*	.28	.19	.07
Standards	*.50*	.00	—.12	.34
Instigation	*—.42*	.05	*—.38*	—.31
Participation	.13	.05	—.09	*—.55*
Positive reactions	.14	.01	*.41*	—.19
Negative reactions	—.33	—.24	*—.44*	—.14

* Italicized correlations are significant at or beyond the .05 level of confidence (one-tailed test).

tion of the eight pertaining to this variable was an unanticipated negative one: fathers who expressed strong desires that their daughters be intellectually competent had daughters who performed less adequately on the reading-achievement test than did daughters of fathers who were less concerned with their daughters' intellectual activities and abilities.

The mothers' *evaluations* of their children's general intellectual competence were associated with their children's academic performances, but the evaluations of the fathers were not. Both the boys' and girls' reading-test performances were positively and significantly related to their mothers' assessments of their general intellectual competence. The children's arithmetic-test performances were positively correlated with the mothers' evaluations, though falling just short of statistical significance. In contrast, none of the fathers' evaluations of their children was related to these children's scholastic-achievement, test-taking behaviors. This finding—that the mothers' evaluation of their children's general intellectual performances were similar to their children's academic performances, while the fathers' evaluations were not—

may have been due to the fact that mothers are usually home to receive the after-school reports from their children regarding their academic successes and failures, while most fathers are not. In addition, it is a common observation that mothers far outnumber fathers in school situations where concrete information is provided regarding their children's academic performances, (e.g., PTA meetings and parent-teacher conferences). Finally, it may be that fathers more frequently based their judgments of their children's general intellectual competence on their intellectual performances observed in the home (e.g., efforts on puzzles, quiz games, etc.) than did the mothers.

Consistent with the findings on evaluations was the fact that the mothers' *satisfactions and dissatisfactions* with their children's general intellectual-achievement efforts were also more often positively associated with the children's achievement-test performances than were those of the fathers: three of the four significant correlations obtained pertained to the mothers' expressed satisfaction with the adequacy of their children's intellectual-achievement performances.

Parental *standards* for the children's general intellectual performances were unrelated to the children's demonstrated competence on the academic-achievement tests with two exceptions. Both of these pertained to the standards the mothers held for their daughters. Mothers who set high standards for their daughters' intellectual-achievement efforts, in contrast with mothers whose standards were less demanding, had daughters who were more proficient on both the reading- and arithmetic-achievement tests. These correlations, as well as a number of those found in the tables which follow, illustrate an inevitable problem inherent in most parent-child research. When significant correlations are obtained between parent and child behaviors, when might it be legitimate to assume the former caused the latter, and when might the opposite be true? The positive association of the mothers' achievement standards for their daughters and these girls' academic-test performances may have been a function of the following: (*a*) high maternal achievement standards induced the girls to strive for, and become proficient in, the academic areas under consideration, while low maternal standards produced the opposite effect; or (*b*) the mothers adjusted their intellectual-achievement standards for their daughters according to the girls' demonstrated academic proficiences; or (*c*) the correlations obtained may be a function of both (*a*) and (*b*).

b. Behavioral variables. The remaining correlations listed in Tables 3 and 4 focus on reported parental behaviors rather than parental attitudes. The degree of the parents' *instigation* of their children toward intellectual-achievement pursuits was predictive of the children's achievement-test performances only for the girls. Girls who performed especially well on the tests had mothers and fathers who were *less* prone to encourage and push them toward intellectual activities than were parents of the less academically proficient girls. Regarding the parents' *participation* with the children in intellectual activities, these parental behaviors bore little relation to the competence the children demonstrated on the academic-achievement tests. In only one instance—i.e., the fathers' participation and their sons' performances on the arithmetic-achievement test—was the correlation significant; fathers of boys who were especially competent in this area spent less time with their sons in intellectual activities than did the fathers of the less competent boys. There was, thus, no evidence in the present study that the amount of parental participation with children in intellectual activities *per se* had any positive impact on the children's academic achievements. The negative correlations obtained between parental instigation and participation and the children's achievement-test performances suggest, though cannot prove, that these parental behaviors might be reactions to the children's efforts rather than antecedent and causal factors in these performances. It is possible, for example, that many parents of grade-school-age children—when the child's academic efforts are competent ones—feel little need to encourage such endeavors or to spend additional time with the children in these pursuits. Conversely, parents of a child who performs relatively poorly in academic situations may become concerned with his ineptitude, and increase their instigational efforts and participation with him in intellectual-achievement activities.

The two final antecedent variables of this study pertained to *parental reactions* to the children's intellectual-achievement behaviors as these predicted the children's academic-achievement-test performances. These variables, historically, have been the major focus of attention of researchers concerned with parent behaviors as determinants of children's personality development. In the current investigation, an attempt was made to assess the reactions of the parents to their children's intellectual-achievement efforts, and to relate these reactions to the levels of performance which the children evidenced on standard academic-achievement tests. The only finding indicating an influence of these parental behaviors on the children's performance—if a causal relationship is assumed—was a cross-sex one; both positive and negative reactions of the fathers to their daughters' intellectual efforts predicted their daughters' academic proficiency. The mothers' reactions, in contrast, were essentially unrelated to their daughters' performances, while neither the fathers' nor the mothers' reported praise or criticism was predictive of their sons' achievement-test scores. In short, the only evidence that the parents' direct rewards and punishments may have influenced their children's academic performances occurred exclusively between fathers and their daughters. Girls who performed especially well on the reading-achievement test had fathers who more often praised and rewarded, and less often criticized and punished, their general intellectual-achievement behaviors. A similar relation obtained for the girls' arithmetic performances.

D. Significant Findings

When the total pattern of significant correlations found in the current study is evaluated, the most striking finding is that the parents' attitudes and behaviors (both general and specific) were associated with their daughters' performances on the scholastic-achievement tests much more frequently than with those of their sons. Of the 18 significant correlations obtained between the Parent Interviews I and II data and the children's demonstrated academic competence, only three pertained to the boys. Why should these differences obtain? One possibility for this finding is that grade-school-age boys may differ from girls in their susceptibility to adult influence. Two unpublished sets of data by the authors of this report support this idea. First, ratings of free-play behavior of another sample of children in the same age range as the current child sample revealed that the amount of the children's achievement efforts and the amount of their approval-seeking from adults were positively and significantly related for the girls (Rho = .46), but unrelated (Rho = .03) for the boys. In other words, the girls' achievement strivings were directly related to their apparent desire for approval from adults, while the boys' achievement behaviors were more autonomously determined. It appeared that the boys had less need to use adults' reactions to define the competence of their efforts than did the girls, possibly because the boys may have developed more-internalized achievement standards. Additional evidence suggesting that young boys' achievement performances may be less contingent on the reactions of others than are those of girls' was obtained on the sample of *S*s employed in the current study. As a part of a different (as yet unpublished) investigation, the children were administered a specially constructed Children's Intellectual Achievement Responsibility Questionnaire. This questionnaire was designed to measure the extent a child attributes his intellectual-achievement successes and failures to his own instrumental behaviors rather than as a product of the behaviors and reactions of other persons. The boys' belief in self-responsibility correlated positively with their performances on the academic-achievement tests used in the current study, while these variables were not significantly related for the girls. The specific correlations between the boys' belief in self-responsibility and their reading- and arithmetic-achievement-test performances were .49 and .36 respectively. For the girls, these correlations were —.16 and —.23. In summary, to the degree that boys' achievement striving has been found to be unrelated to their approval-seeking from adults, and, to the degree that their academic proficiencies were associated with their belief in self-responsibility, their achievement behaviors appeared to be more independent and autonomous of adult reactions than those of the girls. Because of this, parental attitudes and behaviors may have less impact on, and therefore be less predictive of, the academic performances of boys of this age than of girls. The findings of the current study are congruent with this possibility. It should be strongly emphasized, however, that this reasoning rests on several assumptions, as well as limited research data, and must await more definitive tests in future investigations.

E. Summary

This study investigated relations between parents' attitudes and behaviors toward their children's general intellectual-achievement efforts, and their children's performances on standard academic-achievement tests. The sample was comprised of 40 early-grade-school-age children and their fathers and mothers. The children were administered standard intelligence and scholastic-achievement tests. The parents were individually interviewed regarding their general parental behaviors (affection, rejection, nurturance), as well as their specific attitudes and reactions to their children's everyday intellectual-achievement efforts.

The following results were obtained:

1. Correlations between the children's *IQ* scores and their performances on the scholastic-achievement tests were of the same general magnitude found in most past research on children's intelligence and academic performances.

2. General parental behaviors which significantly predicted the children's academic-test performances pertained solely to mothers and their daughters; mothers of academically competent girls were less affectionate and less nurturant toward their daughters than were the mothers of the girls who were less proficient.

3. Certain specific attitudes and behaviors of the parents toward their children's intellectual-achievement behaviors were predictive of the children's academic-test performances; others were not. First, neither the mothers' nor fathers' expressed values for the children's intellectual experiences were positively associated with the children's observed performances. Second, both the mothers' evaluations of, and satisfactions with, their children's general in-

tellectual competence were positively related to these children's actual academic performances, while those of the fathers were not. Third, parental instigation and participation, when correlations were significant, were negatively associated with the children's academic performances. Fourth, the positive and negative reactions of the parents to the children's intellectual-achievement efforts were predictive of the children's academic-achievement-test performances for father-daughter combinations only; the more proficient girls had fathers who more often praised, and less often criticized, their everyday intellectual-achievement attempts than did the less academically competent girls.

4. Many more significant relations obtained between the parents' attitudes and behaviors and their daughters' academic proficiency than occurred between these parental attitudes and behaviors and the boys' performances.

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PARENTS' ATTITUDES TOWARD THEIR PERSONAL ACHIEVEMENTS AND TOWARD THE ACHIEVEMENT BEHAVIORS OF THEIR CHILDREN*[1]

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A. INTRODUCTION

It is generally assumed that parents' evaluations, aspirations and attitudes concerning their children are based, to some extent, on their feelings and attitudes about themselves. Little research on this topic has been reported, however. Considering the fact that many clinical and research psychologists accept parents' statements about their children as reliable data, the study of the ways in which parents' self-attitudes may influence their descriptions of their children seems warranted.

There are many ways in which parents' thinking about themselves may affect their perceptions and evaluations of their children. A parent who excels in a particular skill may project his superiority when evaluating his offspring, or he may tend to underestimate his child as a result of using his own skills as a yardstick. One parent may find the same inadequacies in his child which he feels regarding himself, while another parent with inferiority feelings may perceive positive attributes in his child in order to compensate for his own weaknesses. Consequently, the exact nature of relations between parents' self-attitudes and their perceptions and evaluations of their children is likely to be quite complex. The area under study, the constructs used to describe the parent and the child, and the measurement techniques employed may all influence the direction and extent of relationships found in a given investigation.

Despite many possible differences, certain consistent trends might be expected between parents' self-attitudes and their descriptive statements about their children. First, it seems probable that a parent with a positive self-concept

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will tend to describe his child in a more favorable manner than a parent who is critical of himself. The parent may reason that his own competence and positive attributes will result in the development of a "good" child or that hereditary or identification factors will lead to his child's being "a chip off the old block." The parent with a negative self-concept, on the other hand, may think that his own difficulties and inadequacies will cause problems for his child, or he may view his child as an extension of his own personality with similar deficiencies. Another factor likely to influence the relationship between parent self-attitudes and parents' descriptions of their children is the parent's satisfaction or dissatisfaction with his life in general. The relatively content parent is apt to approach any evaluation of his child with a more positive set than the dissatisfied parent. The parent who feels satisfied with his own life is apt to attach less significance to his child's difficulties and deficiencies, while the parent who is dissatisfied with his life may be prone to judge his child more critically.

Consistent with the above reasoning, Sears, Maccoby and Levin (3) cite low but significant correlations between mothers' reports of child aggression and characteristics of the mothers' personalities rated from their statements in an interview. This investigation found that the higher the mother was rated in child-rearing anxiety, dissatisfaction with her current situation, and disagreement with her husband about child-training matters, the more aggressive the child was described by the mother. Also, the lower the mother's self-esteem and esteem for her husband, the greater the aggressiveness she attributed to the child.

A systematic study of relations between parents' attitudes and evaluations of themselves and their descriptions of their children might begin with the use of parallel concepts (i.e., where the characteristics of the child which are assessed are the same as those on which data has been obtained for the parent himself). This approach allows direct comparisons between a score on a specific parameter of the parent's behavior with that parent's evaluation of his child on the same parameter. Under these circumstances, the question arises, will the parent describe his child as similar or different from himself? The answer is likely to depend on the nature of the relationship between the parent and his child. The greater the acceptance and affection a parent has for his child, the more he is apt to attribute his own positive characteristics to his child, but not his negative ones. The rejecting parent, on the other hand, may be prone to project his own negative qualities to his child to a greater extent than his positive qualities. Undoubtedly many other aspects of the parent-child relationship also affect the way in which a parent associates his own personality characteristics with those of his child (such as the degree the parent fosters independence, the extent of his dominance or nurturant behaviors with his child, and the amount of time he spends interacting with his child).

Because of the complexity of this area, the present investigation was an exploratory one in which an effort was made to determine relations between parents' self-attitudes and their descriptions of their children specifically within the area of achievement. Parallel information was obtained from the parents on their own achievement and on their attitudes about their children's achievement behaviors. The concepts employed in the study and their definitions are presented below: first, as they apply to the parent and, second, as they apply to the parent's attitudes concerning his child's achievement.

Achievement Value: the degree of importance the parent places (*a*) on his ability to perform competently in an achievement area, and (*b*) on his child's ability to perform competently.

Expectancy: the level of competence at which the parent feels (*a*) that he characteristically is able to perform in an achievement area, and (*b*) that his child usually performs.

Minimal Standard: that level of competence on a scale of excellence below which the parent will feel dissatisfied and above which he will feel satisfied (*a*) with his own performance, and (*b*) with the performance of his child.

Satisfaction-Dissatisfaction: the amount of satisfaction *vs.* dissatisfaction the parent feels regarding (*a*) his performance in an achievement area, and (*b*) his child's performance in that achievement area.

Each of the above variables was assessed in four achievement areas. These areas were (*a*) intellectual achievement—activities which emphasize learning, reasoning, memory and the use of symbols; (*b*) physical-skills achievement—activities which chiefly necessitate gross motor coordination; (*c*) artistic achievement—activities which stress esthetic self-expression and esthetic discrimination; and (*d*) mechanical achievement—activities which require fine motor coordination.

B. METHOD

The sample of the study consisted of 40 families: 20 girls and 20 boys, and each child's mother and father. The boys and girls were distributed equally in the first, second and third grades at the beginning of the study. The children were intellectually superior to national norms; the mean Stanford-Binet *IQ* of the child sample was 124 with an *SD* of 16. The families resided in southwest Ohio, and the majority lived in villages with a population of less than 10,000. The sample was reasonably representative of the full range of socioeconomic levels according to Hollingshead's Two Factor Index of Social Position (2), with only the lower class not represented. The educational level of the parents and the vocational status of the fathers was higher than current national norms. Approximately one-half of the fathers and one-fourth of the mothers were college graduates; and approximately one-fourth of each had no college experience. Classification of fathers' occupations into Hollingshead's seven groups resulted in over twice as many falling into the three highest classes (executives, managers, administrative personnel; major and minor professionals; and owners of businesses), as in the four lowest classes (clerical, sales, skilled and semiskilled workers, and small farmers). The mothers were about equally divided between those who were full-time housewives and those who had an outside occupation. Concerning the size of the families, over three-fourths of the children had at least one sibling and one-half had two or more. A more complete description of the sample can be found elsewhere (1).

Interviews were held with the parents on two occasions separated by approximately one year. Each parent was seen individually, and each session lasted from two to three hours. Interview A, which dealt in part with the parent's attitudes concerning his child's achievement, was conducted during the initial session; and Interview B, which focused on the parent's own achievement needs and behavior, was administered during the second meeting.[2] On both occasions, each set of parents was seen simultaneously, but separately. All mothers were interviewed by one of the authors and all fathers by another.

1. *Interview A*

Most of the questions in this interview, dealing with the parent's attitudes concerning his child's achievement behaviors, were presented in a semi-structured manner; i.e., specific topics were covered, but the interviewers were free to rephrase questions, encourage elaboration of statements, and probe in order to obtain maximum data. Each of the four achievement areas was discussed separately. Before starting each of these sections of the interview, the interviewer defined the achievement area under consideration. The parent then was asked to make several ratings concerning his child's efforts in the achievement area to be discussed. These ratings were used to open the discussion and to foster the parent's elaboration of his feelings and reasons for the ratings, and so that he might cite specific incidents illustrating his decisions. Following this open-ended discussion, more-structured questions were asked designed to elicit additional data pertinent to the variables to be rated. The variables rated were these: The parent's *Attainment Value* for his child was rated from his statements indicating his desire that his child demonstrate interest, effort, or competence in an achievement area. The parent's *Expectancy* regarding the success of his child's efforts was inferred from his discussion of his child's competence in past achievement activities as well as from his expectations regarding the probable competence of his child in the near future. The parent's *Minimal Standards* were rated from his direct statements concerning the level of competence of his child's performances which pleased and displeased him, as well as from his satisfaction or dissatisfaction stated during the interview with given levels of competence demonstrated by the child. The parent's *Satisfaction-Dissatisfaction* with his child's achievement behaviors was assessed from the amount of pleasure or displeasure he expressed to the interviewer about his child's interest, participation, effort, and competence in an achievement area. This variable was *not* based on the parent's reports as to how he reacted behaviorally to his child's achievement behaviors.

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[2] A copy of Interviews A and B may be obtained on request from the authors.

Ratings of the 80 parent interviews of Interview A were made from typescripts by the author who had not participated in any of the interviewing. All identifying information dealing with the parent's own achievement behavior was deleted from the typescripts before the ratings were made. The ratings were done by achievement area; all typescripts on one area were rated before the next area was read and rated. Interrater reliabilities were established with one author, who rated 20 randomly selected cases of the father interviews, and with another author, who rated 20 of the mother interviews. Rank-difference correlations between the raters are reported in Table 1.

2. *Interview B*

This interview—dealing with the parents' own achievement attitudes, motivations, and behaviors—was divided into the same four achievement areas as were covered in the previous interview with the parents regarding their children. Each achievement area was described to the parent before starting the discussion of that area. The interview questions were more structured and specific than those in Interview A in that each question focused on obtaining information relevant to a specific variable. The questions sampled both recreational and work experiences, dealt with past and present activities, and sometimes sought reactions to hypothetical achievement situations. The

TABLE 1
INTERRATER RELIABILITIES OF PARENT INTERVIEWER A

Parent variable	Mothers	Fathers
	Intellectual-achievement area	
Attainment value	.50	.80
Expectancy	.78	.94
Satisfaction-dissatisfaction	.85	.96
Minimal standard	.63	.57
	Physical-skills-achievement area	
Attainment value	.73	.80
Expectancy	.94	.84
Satisfaction-dissatisfaction	.87	.89
Minimal standard	.72	.77
	Artistic-achievement area	
Attainment value	.83	.78
Expectancy	.58	.86
Satisfaction-dissatisfaction	.80	.88
Minimal standard	.60	.86
	Mechanical-achievement area	
Attainment value	.79	.81
Expectancy	.85	.88
Satisfaction-dissatisfaction	.78	.83
Minimal standard	.86	.95

parent's response to each interview question was scored separately, and the final rating for each variable in an achievement area was based on the composite of the scores given to responses on all questions pertaining to that variable. The rating variables for Interview *B* were the following:

Attainment Value: This variable was rated from the parent's statements concerning (*a*) the reasons why he participated or would like to engage in an achievement activity, (*b*) the amount of time and effort he devoted to the activity in comparison with other interests and activities, (*c*) his ideal goals for competence in the activity, and (*d*) his statements regarding the importance of being competent in the achievement activity under discussion.

Expectancy: This was rated from the parent's evaluative statements about his performance, taking into account the complexity and difficulty of the tasks he reported performing in the achievement area. When the parent's participation in an area was minimal, he was asked how well he would anticipate performing if he were to engage in additional activities representing the achievement area.

Minimal Standard: This variable was rated from the parent's general statements as to the level of competence which usually pleased or displeased him. Also, the parent's minimal standard was inferred from his satisfaction or dissatisfaction with specific levels of competence at which he had performed in the past.

Satisfaction-Dissatisfaction: The parent's statement of his feelings as well as other indications of positive and negative affect concerning his performances were referents for this rating. An average rating represented approximately equal feelings of satisfaction and dissatisfaction; an above average rating represented greater satisfaction than dissatisfaction; and a below average rating, greater dissatisfaction than satisfaction.

Following completion of each interview, the father-interviewer rated each of the father interviews, and the mother-interviewer rated each mother interview. The interviews were recorded, and a reliability rater rated 20 randomly selected mother interviews, while a second reliability rater rated 20 of the father interviews after listening to the recordings.[3] Rank-order correlations of interrater reliabilities are shown in Table 2.

TABLE 2
INTERRATER RELIABILITIES OF PARENT INTERVIEW B

Parent variable	Mothers	Fathers
	Intellectual-achievement area	
Attainment value	.96	.87
Expectancy	.94	.90
Satisfaction-dissatisfaction	.88	.63
Minimal standards	.91	.81
	Physical-skills-achievement area	
Attainment value	.95	.94
Expectancy	.84	.91
Satisfaction-dissatisfaction	.85	.65
Minimal standards	.83	.79
	Artistic-achievement area	
Attainment value	.93	.63
Expectancy	.96	.85
Satisfaction-dissatisfaction	.93	.66
Minimal standards	.95	.89
	Mechanical-achievement area	
Attainment value	.96	.91
Expectancy	.94	.79
Satisfaction-dissatisfaction	.90	.83
Minimal standards	.89	.66

C. RESULTS AND DISCUSSION

Relations between the parents' own achievement characteristics and their attitudes toward their children's achievement behaviors will be considered separately for each achievement area of the study. Correlations were computed for the total group of mothers and their children, for the mothers of girls separately, and for the mothers of boys. Similarly, separate correlations were run between the total group of fathers and their children, for the fathers of girls separately, and for the fathers of boys. The Spearman rank-difference correlation was used for all measures of association. Two-tailed tests of significance were used in all analyses because of the exploratory nature of the study.

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[3] Dr. Frances Lemcke was the reliability rater for the father interviews, and Mrs. Marion Freeman was the reliability rater for the mother interviews.

Table 3 presents the correlations for the *intellectual*-achievement area. Only relations between the parents' own values and standards and those they held for their children were statistically significant. The greatest similarity in the parents' attitudes about their own and their children's intellectual activities pertained to the importance (attainment value) they placed on intellectual achievement. The greater the value both mothers and fathers placed on intellectual achievement for themselves, the more they valued intellectual achievement for their offspring. It is interesting to note that when correlations were run separately for the boys and girls, the greatest similarity was found between the parents' attainment values for themselves and those they held for their daughters. The importance the parents placed on intellectual competence for their daughters was closely tied to the values they held for themselves, whereas the importance they placed on intel-

TABLE 3

PARENTS' SELF-ATTITUDES AND THEIR ATTITUDES TOWARD THEIR CHILDREN'S INTELLECTUAL ACHIEVEMENTS

Self-attitudes	Attitudes for children	For daughters	For sons	For all children
		Mothers		
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.41	.29	.36*
Expectancy	Expectancy	—.04	.25	.11
Minimal standard	Minimal standard	.30	.41	.33*
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.15	.22	.15
		Fathers		
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.55*	.17	.41**
Expectancy	Expectancy	—.09	—.22	—.06
Minimal standard	Minimal standard	.01	.47*	.17
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.42	—.34	.03

* Significant at the .05 level (two-tailed).
** Significant at the .01 level (two-tailed).

lectual competence for their sons was more independent of their values for themselves. The findings were different concerning the relations between the minimal standards the parents set for themselves and those held for their children in intellectual activities. Here the tendency was for both the mothers and the fathers to set similar standards for their sons as they held for their own intellectual performance. Fathers, in particular, wanted their sons to perform as well as they would like to perform themselves.

The variations in the correlations according to the sex of the children are of particular interest. The intellectual values the parents held for their daughters were more similar to their own than the values they held for their sons. Conversely, the standards the parents set for their sons' intellectual performances were more like those they held for themselves than were the minimal standards they set for their daughters. These differences in parents' attitudes toward the intellectual activities and performances of their children may reflect certain cultural stereotypes concerning young children's intellectual-achievement activities. Frequently it is considered inappropriate for a grade-school boy to pursue intellectual activities with too great intensity, especially at an early age. For example, some parents believe that a young boy who neglects other more "masculine" activities in favor of schoolwork and solitary studying may develop into a "bookworm" or an "oddball." Grade-school girls, on the other hand, often are expected to emphasize intellectual activities, and are less likely to be considered unusual for doing so. For this reason, parents who place a high degree of value on intellectual achievement for themselves may more readily consider this important for their young daughters than for their young sons. In the case of minimal standards, however, the parent who demands a high level of intellectual performance from himself may be more willing to accept less from a daughter than from a son. Since intellectual competence is associated with vocational success and the male role of breadwinner, parents with high intellectual standards for themselves are more likely to establish high standards for their sons than for their daughters.

The least similarity between the parents' attitudes concerning their own achievements and those about their children's achievement behaviors was found in the *physical-skills* area. Only one of the 24 correlations in this area, shown in Table 4, was significant; i.e., fathers set similar standards for their children's physical-achievement performances as for their own. There are several likely *post hoc* reasons for the lack of association between the parent and child variables in this area. First, the physical-skills-achievement experiences of children of early-grade-school age tend to involve very different skills

TABLE 4

PARENTS' SELF-ATTITUDES AND THEIR ATTITUDES TOWARD THEIR CHILDREN'S PHYSICAL-SKILLS ACHIEVEMENT

Self-attitudes	Attitudes for children	For daughters	For sons	For all children
	Mothers			
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.02	—.07	.17
Expectancy	Expectancy	.05	.12	.05
Minimal standard	Minimal standard	—.33	.22	—.04
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.07	.18	.16
	Fathers			
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.04	.43	.24
Expectancy	Expectancy value	.36	—.07	.01
Minimal standard	Minimal standard	.01	.36	.35*
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	—.25	—.06	—.10

* Significant at the .05 level (two-tailed).

and activities from those of an adult—more so than is the case in other achievement areas. For example, the physical-skills activity of a young child frequently consists of developing the basic coordination or skills associated with simple, gross motor activities such as riding a bicycle, skating, or playing an informal group game; whereas physical-skills achievement for an adult is more apt to involve skill in a complex activity or sport; e.g., bowling, swimming, golf, etc. A parent who places little value and sets low standards for athletic activities for himself may still be highly concerned with his child's developing the basic, gross motor coordination associated with many children's activities. Conversely, another parent who eagerly strives to improve his bowling average, for example, may see his child's hopscotch and rope-jumping activities simply as play, rather than as activities involving physical-skills competence, and thus may fail to formulate any standards and values for these activities for his child. Another possibility for the few relationships found between the achievement variables for parents and their attitudes for their children in this area is that, compared with other areas, performance is often based on many factors other than skill. A child's size, physical development, and health may influence his parent's attitudes toward his physical activities more than is true of other achievement areas in which the child engages. Even though a parent may want his child to excel in athletics, he may stifle this wish for realistic reasons such as his child's being frail, small, or poorly coordinated. Similarly, a parent who generally does not consider physical skills important for himself or his children, may begin to attach significance to such activity for his child because of his child's good physique or abundant energy. Thus, it seems likely that such objective factors may play a more dominant part in parents' considerations of their children's physical-skills achievement than is true in the other achievement areas. Concerning the especially small correlations found between the mothers' self-attitudes and the attitudes they held for their children's physical-skills achievement, it may be that mothers are less involved with this achievement area than with others and, consequently, are less likely to interject their own values into their perceptions of, and attitudes about, their children's behavior.

In contrast with the physical-skills area, analyses of the *artistic*-achievement data, shown in Table 5, resulted in many instances of significant similarity between the parents' self-attitudes and their attitudes toward the achievements of their children. Both fathers and mothers valued artistic achievement for their children to an extent comparable to the value they placed on this type of achievement for themselves. In this case, the similarity of values was in a same-sex direction; i.e., mothers transferred their values to their daughters, and fathers, to their sons. A number of the relations between the parents' expectancies of success for themselves and their expectancies for their children's artistic competence, particularly for their sons, were also significant. Apparently, the parents may have felt that there

TABLE 5
PARENTS' SELF-ATTITUDES AND THEIR ATTITUDES TOWARD THEIR CHILDREN'S ARTISTIC ACHIEVEMENTS

Self-attitudes	Attitudes for children	For daughters	For sons	For all children
	Mothers	$(N=20)$	$(N=20)$	$(N=40)$
Attainment value	Attainment value	.54*	.24	.43**
Expectancy	Expectancy	.40	.52*	.47**
Minimal standard	Minimal standard	.32	.33	.38*
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	—.07	.07	.03
	Fathers	$(N=20)$	$(N=20)$	$(N=40)$
Attainment value	Attainment value	.40	.54*	.47**
Expectancy	Expectancy	.26	.57**	.43**
Minimal standard	Minimal standard	.07	.00	.08
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.35	.39	.36*

* Significant at the .05 level (two-tailed).
** Significant at the .01 level (two-tailed).

was a greater likelihood of their artistic ability, or the absence of this, influencing their children than was the case concerning abilities in the other achievement areas. In part, the reason for this may lie in the assumption frequently made that artistic talent, or its absence, is primarily an inherited rather than a learned ability. Other significant correlations in the artistic-achievement area indicated that mothers tended to apply their own artistic standards to the artistic efforts of their offspring, while fathers did not. However, the fathers had similar feelings of satisfaction or dissatisfaction concerning the artistic efforts of their children as they did regarding their own artistic endeavors.

Several interesting differences were found between the mothers' and fathers' tendencies to hold similar attitudes toward their children's *mechanical* achievement as they did toward their own. Correlations for this area are shown in Table 6. None of the relations between the mothers' attainment values and those they held for their offspring was significant, possibly because women usually are not as personally involved with mechanical achievement as are men. The fathers, on the other hand, showed a tendency to value mechanical achievement for their children similarly to the value they placed on such experiences for themselves. Surprisingly, however, the fathers applied their values for mechanical achievement to their daughters more than to their sons. Mothers indicated a strong inclination to feel the same

TABLE 6
PARENTS' SELF-ATTITUDES AND THEIR ATTITUDES TOWARD THEIR CHILDREN'S MECHANICAL ACHIEVEMENTS

Self-attitudes	Attitudes for children	For daughters	For sons	For all children
	Mothers			
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.16	.16	.15
Expectancy	Expectancy	—.07	.67**	.36*
Minimal standard	Minimal standard	.11	.48*	.27
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.56**	.71**	.64**
	Fathers			
		($N = 20$)	($N = 20$)	($N = 40$)
Attainment value	Attainment value	.53*	.37	.46**
Expectancy	Expectancy	—.12	.53*	.27
Minimal standard	Minimal standard	.22	.23	.19
Satisfaction-dissatisfaction	Satisfaction-dissatisfaction	.00	.39	.20

* Significant at the .05 level (two-tailed).
** Significant at the .01 level (two-tailed).

about their children's mechanical efforts as about their own. If a mother was pleased with her own mechanical achievements, she was likely to be pleased with her child's mechanical work; and if she was displeased with her own proficiency in this area, she was very likely to be displeased with her child's efforts. Mothers also transferred their own minimal standards in the mechanical area to their sons. Both mothers and fathers attributed mechanical competence to their sons in accord with their expectations for their own competence. However, their estimates of their own mechanical competence and their estimates of the mechanical competence of their daughters were not related significantly. It may be that parents consider mechanical skills and achievement chiefly as a masculine activity and, therefore, are more likely to describe and evaluate their sons' mechanical ability and accomplishments similarly to their own skills than they do their daughters'.

In general, the magnitude of the correlations between the parents' attitudes regarding their own achievements and their attitudes about their children's achievements varied considerably depending on achievement area, the specific variables under consideration, and sex of the parent and the child. The variations and the complexity of the findings argue against overgeneralizing about similarities between parent self-attitudes and their attitudes about their childrens' achievement. At the same time, the significant correlations obtained do indicate that parents' attitudes and evaluations of their children's achievements often are closely associated with their ideas and feelings about their own achievement efforts and competence. Several specific trends are apparent. First, when achievement areas are compared, most of the significant relations are found to exist in the artistic and mechanical areas. This may be a function of the fact that performance in these areas is more difficult to evaluate, and standards of excellence tend to be more subjective than for intellectual and physical-skills competence. Consequently, objective criteria provide less of a guide for parents' ideas of what they want and expect of their children's artistic and mechanical efforts. The more objective the information a parent has about his child's behaviors in an achievement area—as is likely to occur in the intellectual area from reports of schoolwork, and in the physical-skills area from comparing a child with his siblings and playmates—the more opportunity the parent has to base his thinking on realistic considerations, and the less likely he is to project his attitudes and evaluations of his own achievement behaviors onto his child.

The data indicate a second trend. The correlations generally were higher and significant in more instances between the parents' attitudes concerning their own and their sons' achievement than between their attitudes for themselves and those held for their daughters. It is possible that this trend reflected a greater overall concern on the part of the parents with the achievements of the boys than with those of the girls. Tests of differences were computed between the parents' attainment values for their sons and daughters using Wilcoxin's Unpaired Replicates Test, and some support was found for the hypothesis that parents value achievement more for boys than for girls. In two of the four achievement areas, the attainment values held by the fathers were significantly higher for boys. Fathers placed greater value on achievement in physical-skills activities (.05 level of significance) and in mechanical activities (.01 level of significance) for their sons than for their daughters. Also, of the eight comparisons made, only one was not consistent with the trend for the parents' attainment values to be higher for the boys than for the girls. This exception was that mothers tended to place greater emphasis on artistic achievement for their daughters than for their sons. This was not statistically significant, however.

Finally, a few trends concerning sex of the parent and sex of the child were found. Mothers were more prone to apply their own minimal standards to the achievement efforts of their children than were fathers, while fathers more often held similar values for their children's achievements as for their own. It is also interesting to note that fathers tended to project their feelings of satisfaction and dissatisfaction to their children's achievement in the artistic area, while mothers did so more frequently in the mechanical area. If it is assumed that fathers generally are not as interested in artistic achievement as are mothers, and that mothers are less interested in mechanical achievement, it may be that satisfactions and dissatisfactions are most readily projected by parents when they are not very personally involved with a particular type of achievement.[4] While this explanation runs counter to the idea that projection—particularly of inadequacies—is more likely to occur when persons are emotionally involved, there is also the possibility that personal involvement on the part of a parent in a specific achievement area increases his sensitivity to his child's efforts in that area, and results in his obtaining more information about his child's performance. The parent who is highly involved with a particular type of achievement may formulate his feelings of satisfaction or dissatisfaction in terms of his knowledge of what the child can or cannot do, while the parent who is not so involved in that type of achievement may lack the motivation to obtain such information. He, therefore, may think about his child's efforts as he thinks about his own as a function of naive projection. In all probability the concordance of parents' self-attitudes and their attitudes concerning their children may be fostered, at times, by a high degree of emotional involvement in an activity on the part of the parent, and, at other times, by a lack of involvement.

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[4] Since, in the present study, the ratings for each parent were made on a relative basis according to sex of the parent—i.e., each rating for mothers was made relative to the data obtained on all the other mothers, and each rating for fathers was made relative to the data on the other fathers—meaningful analyses of sex differences *between* parents could not be made. Also, any absolute sex differences found in this data might have involved an interviewer bias, since each interviewer interviewed all parents of only one sex.

D. SUMMARY

Mothers and fathers of 40 early-grade-school children were interviewed about their attitudes concerning their children's achievement behaviors in four achievement areas: intellectual, physical skills, artistic, and mechanical. The parents were also interviewed at a later time regarding their own achievement behaviors in these four areas. Correlations were computed between the parents' self-attitudes and their attitudes toward their children for four achievement variables: attainment value (or importance), expectancy for performing competently, minimal achievement standards, and satisfaction-dissatisfaction with achievement efforts. Correlations were run separately by sex of parent and sex of child. The magnitude of correlations varied depending on the achievement area, the specific variables, and the sex of the parent and sex of the child.

Major findings were:

1. Both parents held values for the intellectual achievement of their children, particularly their daughters, similar to those which they held for themselves.

2. The least similarity between parents' self-attitudes and their attitudes concerning their children's achievement was in the area of physical skills, while most significant correlations were obtained in the artistic and mechanical areas.

3. Mothers and fathers showed strong tendencies to apply their own values and expectancies for success to their offspring in artistic activities.

4. Concerning mechanical achievement, the satisfaction or dissatisfaction mothers felt about their own efforts correlated with their feelings about their children's mechanical activities. Also, the mothers' standards and expectations for the success of their sons in mechanical activities were similar to the standards and expectations they held for themselves. The value fathers placed on mechanical achievement for their children, especially for their daughters, corresponded with their own desires for success in the mechanical area. The fathers' expectancies of success for their sons in mechanical activ-

ities correlated significantly with their own expectations for success in this area.

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STABILITY OF SOCIOMETRIC STATUS IN TWO ADOLESCENT CLASS GROUPS*

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A. Problem

Acceptance by the classroom group is still one of the most important needs of children and adolescents. In one study of fifth graders (5), the researchers reported a low but definite correlation between sociometric choice of the group towards an individual and the individual's appraisal of himself. Other investigators have hypothesized that the use of the choice process is an expression of deep personality tendencies. The individual may seek those who facilitate his development, or others who immerse him deeper in self-defeatist attitudes. In the choice patterns, one often sees the expression of crucial aspects in personality functioning.

In view of the importance of social choice, it is highly desirable to understand the stability of such selection patterns, especially at the adolescent level. One study (6) demonstrated a high degree of constancy in friendship choices over a year period. However, there is still an important need to analyze data on the consistency of choices over varying time periods.

The present study analyzed the consistency of choices in two different groups: one moderately large sample after five months, and another much smaller population followed up after two years.

The present investigation was part of a larger research conducted by the author over the last 10 years (1, 2).

B. Subjects and Procedures

The sample consisted of 298 boys, between the ages of 13 and 15, drawn from schools in New York City and its environs.

The two schools represented were of different economic levels. However, for the purpose of this investigation, the time factor rather than the economic level will be given primary consideration.

The sample from School A was drawn over a five-month period from 10 different class groups. The smaller population over the larger time span

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TABLE 1
POPULATION AND TIME INTERVAL BETWEEN FIRST AND SECOND SAMPLING

School	Number of classes	Time interval	Population
A	10	5 months	246
B	2	2 years	52

compared only two class sections. It should also be pointed out that the study was initiated in school A at the end of one term and was completed by the end of the following semester.

A modified "buddy rating," or sociometric procedure, was used as the criterion of social acceptance. The pupils in each class were asked to list the four boys they would like to have sit next to them the following term, who in their opinion would make the most desirable friends, and also the four boys with whom they would feel uncomfortable, who gave them a feeling of annoyance or uneasiness in the classroom situation. The class groups in which this was accomplished approximated 30 boys.

C. DATA TREATMENT

The students' sociometric choices were scored in class groups by means of a chart developed for this purpose and used in the early studies. For each student the number of rejections was subtracted from the number of acceptances. The difference, positive or negative, was divided by the number of individuals in the class and multipled by 100. The problem in this study was to determine the consistency of acceptance-rejection scores without regard to whether they were high, middle, or low on the criterion of social acceptance.

Within each school the coefficient of correlation was computed between every boy's acceptance-rejection score at the beginning of the study and his score five months or two years later. Further, an index of stability was also determined for each school.[1]

The latter statistic compared the number of students in the same class when the sociometric data were first collected with the class composition after the five-month or the two-year time period.

D. RESULTS

The five-month group was more stable (i.e., showed less change in class structure and evidenced less change in acceptance-rejection scores of individuals). The correlation from the beginning to the end of the term is significant at less than the one per cent level.

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[1] The author wishes to thank Dr. Max Smith and Mr. Peter Bakstansky for their assistance in the design and statistical analysis of the research data.

The two-year B group showed a greater shift in sociometric status. This is especially noteworthy because the composition of the class groups was still quite similar (Index of Stability, .65), even though two years had passed since the first sampling. The correlation is just barely significant at the five per cent level.

TABLE 2

CORRELATION BETWEEN FIVE-MONTH AND TWO-YEAR SOCIOMETRIC SCORES

School	Correlation	Level of significance	Index of stability
A	.69	$< .01$	.87
B	.22	$> .05$	.65

E. DISCUSSION

There are some obvious limitations in the study. The concentration of the sample in the greater New York area possibly limits applications to other parts of the country. Moreover, even within this restricted population, certain environmental variables were uncontrolled. The subsamples, for example, were drawn from different economic levels, and are confined to boys within the 13-15 age bracket. Different results may be obtained at other age levels. In addition, the sample over two years was much smaller than the one used over five months.

However, in spite of these problems, there are still important research guidelines to be deduced from this study. A broad interpretation of our data may reveal the following two major conclusions:

1. There is a high degree of consistency in choice patterns among adolescent boys over a five-month span (i.e., from the end of one term through to almost the completion of the following semester). Some shifts do occur, and the correlation is far from perfect. Nevertheless, a fairly stable sociometric-choice score does seem to obtain when a youngster travels through a term with the same acceptors and rejectors.

2. However, on the opposite side of the coin, it should be pointed out that shifts in popularity position, over time, can occur. Our sample covering the two-year period is small, but the data are provocative and suggestive. It appears highly possible, if our results are substantiated by later studies, that significant shifts in choice pattern can develop, even with the same group of youngsters doing the selecting. Changes may be especially mercurial during

the volatile adolescent period. What was important and desirable behavior in a 13-year-old may become a cause for rejection at 15. The reverse may also obtain.

It is known that changes in popularity can and often do occur. However, they usually do not, according to our investigation, develop over a one-semester period. A more stimulating research question may revolve around the problem of whether it is possible by a change in classroom situation to shift an adolescent's position in a shorter period and thus avoid the "slings and arrows" of rejection. Can placing a youngster (of a low sociometric position) at the end of one term into a new group for the remainder of the year provide the opportunity to begin with a fresh slate?

Psychologists need to pay more attention to the possible therapeutic effects involved in environmental change. This is particularly true at the early adolescent level, when acceptance among peers is so highly valued.

Fiedler (3) points out the therapeutic effects of environmental modifications. He believes that the person may change without benefit of psychotherapy if . . . "the individual is able to get into a group where he could form a relationship in which he was accepted."

Our data seem to suggest that for the rejected child a change in classroom environment might well have therapeutic benefits.

F. SUMMARY

Social acceptance has long been considered an important tool for understanding the individual as well as the class structure. However, few researchers have concentrated on determining the stability of peer choices.

The present study, part of a larger research project, analyzed the social-acceptance scores of adolescents over two different time spans—five months, and two years. A modified "buddy rating" was used as the criterion of social acceptance. The class groups in which this procedure was accomplished contained approximately 30 students. The population consisted of 298 boys, between the ages of 13 and 15, attending schools in the greater New York area.

The acceptance-rejection scores for each individual at the start and at the end of the five-month or two-year period were correlated within each of the two subsamples. Further, an index of stability was determined for each school.

In relatively stable groups, few shifts in sociometric position occur after five months. However, there is a suggestion in a small sample that significant

changes in sociometric position even within similar class groups may develop after two years.

Limitations of the research were outlined. However, certain broad generalizations were suggested. Probably most important was the hypothesis concerning the possible therapeutic effect of environmental change, especially with rejected adolescents. Time by itself may modify friendship choices; however, the process may be facilitated by shifting the classroom constellation.

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LOW PROTEIN DIET AND EMOTIONALITY IN THE ALBINO RAT*[1]

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A. Introduction and Problem

The high incidence of malnutrition in the indigenous people of Africa, and more particularly the widespread protein malnutrition, may well affect the mental efficiency of a considerable section of the community.

Mental manifestations accompany kwashiorkor, the most widespread of the protein-deficiency syndromes, and provide an aid in the diagnosis of the condition. The most marked of the mental symptoms is a mixture of apathy and irritability.

Appreciating the difficulties of establishing adequate control in dietary studies of human subjects, we have endeavoured to explore the effects of low-protein diets on successive generations of white rats.

First-filial-generation low-protein rats have been found to be retarded in growth and intelligence (5, 6), and in a second filial generation the low-protein diet was associated with a delay in both the emergence of motor activity and the response of the rats to auditory stimulation. The second generation was also retarded in intelligence, growth, and development (7).

The present report describes observations made on the maternal behaviour of another parent generation of low-protein rats, and on the behaviour of their male offspring in tests of cage emergence, hoarding, and emotionality. Observations on the weights of the adrenal glands and on blood-cell counts, in the filial generation, are also described.

B. Method

Observations on maternal behaviour were made on six control and eight low-protein female rats of a remote Wistar strain. The rats were housed individually in wire cages measuring 30 × 21 × 21 cm. The experimental rats had been retained on the low-protein diet from the age of 35 days, while

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[1] The authors wish to express their appreciation to B. Nevin for his advice on the statistical analysis of the data.

the control rats were fed the laboratory diet. These rats, which constitute a parent generation, were mated with normal males of the same strain at 100 days of age.

The litters were weaned at 35 days of age, the pups of the experimental group being retained on the low-protein diet. Twenty male low-protein rats and 20 male control rats were used in testing the first filial generation. Two male rats randomly selected from the two largest control litters, and four male low-protein rats, similarly selected from four of the largest experimental litters, were not used in the study.

Details of the composition of the low-protein and the control diets have been given elsewhere (5, 7). The composition of the low-protein diet was based on the work of Miller and Platt (14), who compounded a diet in which the foodstuffs, though of European origin, corresponded in amounts to a typical diet of a rural area in the Gambia. The protein content of the low-protein diet varied between 12.97-15.60 (mean, 14.49) per cent, and that of the normal laboratory diet between 20.1-21.5 (mean, 21.3) per cent. Except for a short period when hoarding behaviour was tested, the rats had unrestricted access to their diet and to water.

C. PROCEDURE

1. *Maternal Behaviour of the Parent Generation*

Recordings were made three times a day as to whether the rat mothers were suckling their litters. The times for making the observations were selected at random from hourly intervals between 8 a.m. and 5 p.m. A litter was regarded as suckling if the majority of the pups were feeding from the mother.

From the second day after birth, the turgor of the nipples of the mother was rated on a five-point scale. The ratings were made on the overall impression of turgor, and the procedure was repeated on every third day until the pups were 17 days of age.

Each rat, when placed in the breeding cages some four or five days prior to littering, was given a piece of hessian cloth approximately six-inches square. Most rats readily tear the cloth into small pieces which are then used for nest building. The nests were rated on a five-point scale, a high score being given to those nests which were well insulated with high walls. Nest ratings were made on every third day from the second day after birth. In all, each nest was rated six times.

The behaviour of the mother in retrieving her litter was recorded. Briefly, the procedure adopted was as follows. It was noted whether the mother was with her litter and whether she was suckling them. The cage door was then opened, and the time taken for the mother to leave the litter was recorded. If the mother had not left her litter after 60 seconds, she was removed. A mother that was not with her litter was immediately removed on the opening of the cage door. The degree of difficulty experienced in removing the mother was rated, a high rating being given where the mother crouched at the back of the cage or attempted to escape, and a low rating where little difficulty was experienced in removing the mother.

After removal of the litter, a platform measuring 45 × 20 cm. and with a wall one cm high was erected in front of the cage. The mother was placed on the platform, at the end remote from the cage, and the time taken to return to the cage was recorded. Each pup was placed singly on the platform, and the time taken by the mother to retrieve the pup was noted. Finally, the type of activity (preening, drinking, eating, and exploring) displayed by the mother after the last of the pups had been retrieved was also recorded.

The testing and observations on maternal behaviour were undertaken in the breeding room where temperatures were maintained between 26.5° and 30° C. After weaning, the rats were kept in a constant temperature of 24° C.

2. *Testing the First Filial Generation*

At 73 days of age, the first-filial-generation male rats were tested on hoarding and cage emergence. A platform measuring 101.5 cm × 15 cm and with walls 15 cm high was placed in front of the cage. For both groups, food pellets of each diet were placed in equal numbers in a small food dish at the end of the platform away from the cage. The cage door was opened and the type and number of pellets hoarded by the rats after 20 minutes was recorded. A record was also kept of the number of rats that failed to emerge from their home cages in the first five minutes of each trial. The cages are normally arranged in rows of five and, by having an adjustable stand for the platforms to rest on, it was possible to test five rats simultaneously.

Each rat was given five trials on the hoarding test. The first three trials were given on successive days and were not preceded by either food or water deprivation. The fourth trial was administered three days after the first three trials and was preceded by 23 hours of water deprivation, though the rats were allowed to drink freely prior to testing.

Immediately following the testing on the fourth trial, the rats were deprived of food for 40 hours, after which they were given a further trial on the hoarding test.

At 150 days of age, the same sample of rats was tested on Hall's open-field test of emotionality. Five trials each of three-minute duration were given to the rats with a 1,100-watt, 240-volt, tungsten lamp suspended 84 cm above the open field. The open field was similar to that described by Hall (9). Fifty days later the test was again administered, though this time four 150-watt, 220-volt lamps were suspended on a square frame at the same height above the field. A noise generator provided a "white-noise" spectrum which was amplified and fed to two loudspeakers (8″ and 4″) mounted coaxially in the centre of the lamp frame. The intensity of the sound in the field was measured by using a General Radio Company Sound Level Meter (Type 759), and was found to be 97.0 db (ref. .0002 dynes/cm^2) at the periphery of the field, and 106.2 db at the centre of the field. The mean intensity of the sound over the whole field was 100.4 db. In this second series the rats were given three trials in the open field, each trial of two-minutes duration.

The number of times the rat defecated was noted, and the amount of ambulation was recorded on a prepared plan of the field for each trial.

At 250 days of age a count of the red and white blood cells was taken. The blood sample was obtained by amputating the tip of the tail. Hayem's solution was used as the diluting fluid for the red cells, and a two per cent acetic-acid solution for the white cells. Following the blood count, the rats were etherised, and the adrenal glands were removed and weighed.

D. Results

1. *Maternal Behaviour of the Parent Generation*

With the exception of the time taken by the mother to return to the nest and the ratings on nest building, there were no significant differences between the means scores of the low-protein rats and the control rats on the various aspects of maternal behaviour.

The mean time taken by the low-protein mothers to return to the cage after being placed on the retrieving board was longer than that taken by the control mothers ($t = 2.26$; $p < .05$).

The mean score of the low-protein rats on nest building was higher than that of the control rats ($t = 3.56$; $p < .01$), indicating that the nests of the low-protein rats were rated as more insulated than the control.

2. *First Filial Generation*

As the distribution of scores of the hoarding trials were skewed, all statistical comparisons were made using a two-tailed Mann-Whitney U test.

Over the five test trials, the low-protein rats hoarded fewer pellets than the control group ($p < .002$). The difference between the two groups was marked in the trial following on food deprivation ($p < .02$), and closely approached the five per cent significance level in the trial following on water deprivation, and also in the first three hoarding trials.

In all five trials, the number of low-protein rats hoarding pellets was lower than the number of control rats hoarding, but the difference was only significant in the trial following on food deprivation ($\chi^2 = 4.44$, $df = 1$, $p < .05$). On grouping the first three trials, the chi-squared value ($\chi^2 = 3.61$, $df = 1$) approaches the five per cent significance level ($\chi^2 = 3.84$, $df = 1$).

Neither the experimental nor the control rats showed any significant preference for the low-protein as compared with the control pellets. The mean number of pellets of each kind hoarded by the two groups was not significantly different over the five trials.

The number of rats emerging from their cages was greater in the control group than in the low-protein group, the differences between the groups being significant in the second trial ($\chi^2 = 5.38$, $df = 1$, $p < .05$), in the trial following on water deprivation ($\chi^2 = 6.42$, $df = 1$, $p < .02$), and in that following on food deprivation ($\chi^2 = 9.64$, $df = 1$, $p < .01$).

With successive trials the number of rats emerging from their home cages increased in both the low-protein and the control groups (Figure 1). The most marked differences between the groups occurred, however, after water deprivation and the trial following on food deprivation. In the last trial, 90 per cent of the control rats and only 50 per cent of the low-protein rats emerged from their cages in the five-minute observation period.

Differences between the low-protein and the control rats on Hall's open-field test were marked. In the first five trials, the mean ambulatory score of the low-protein rats was less than that of the control rats ($t = 3.61$, $p < .001$), while the mean number of boluses was greater in the low-protein group ($t = 2.90$, $p < .01$). Inner-circle activity in the open field was significantly less in the low-protein group ($t = 2.56$, $p < .02$).

Noise was used in retesting the rats on the open field. The mean ambulatory score of the low-protein rats was significantly less than that of the control rats ($t = 3.21$, $p < .01$), while the mean number of boluses was greater in the low-protein group ($t = 2.02$, $p < .05$). Inner-circle activity was significantly less in the low-protein group ($t = 2.05$, $p < .05$).

The correlation between body weight and adrenal weight was positive but not significant in both the control group ($r = .27$, $p > .1$) and the low-protein group ($r = .31$, $p > .1$). The difference in the mean adrenal weights

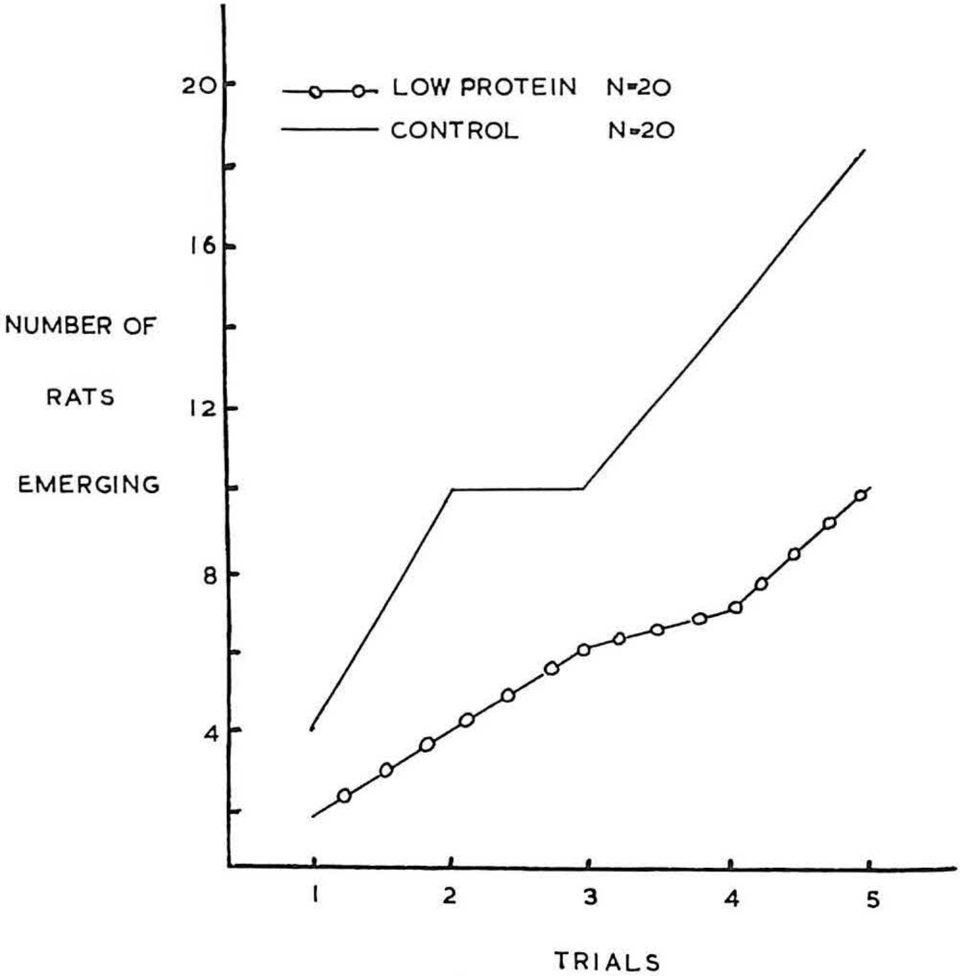

FIGURE 1
CAGE-EMERGENCE OF LOW-PROTEIN AND CONTROL RATS

between the two groups was very significant ($t = 4.907$, $p < .001$), the mean weight of the adrenal glands of the low-protein rats being less than that of the control.

The mean number of red blood corpuscles was greater in the low-protein group than in the control ($t = 4.69$, $p < .001$), though no significant differences between the two groups in the white blood cell count was found ($t = .48$, $p > .6$).

E. DISCUSSION

In the absence of differences between the maternal behaviour of the low-protein and control groups, we should have attributed the behaviour observed in the first generation entirely to prenatal factors or factors associated with the quality or the quantity of the mothers' milk. Having observed some differences in the maternal behaviour of the parent generation, however, we must recognise that the behaviour of the mothers towards their young may contribute to the results obtained in the first filial generation. Moreover, with successive generations retained on the low-protein diet, the change in maternal behaviour may become more pronounced. In a recent study, for example, we have observed an increase in the frequency with which first-generation low-protein rats suckle their young (7). A close interaction between the biological factors associated with the low-protein diet and the maternal behaviours of the mothers is visualised.

In selecting hoarding and cage emergence for the testing of the first-filial-generation rats, we were endeavouring to establish whether differences in the early experience of the low-protein rats would be reflected in their behaviour on these tests. The determinants of adult hoarding behaviour have not been clearly defined, but infant feeding frustration does appear to have some effect upon hoarding in the adult rat (2). The technique used for providing an index of hoarding required the rat to emerge from the cage and traverse the length of the runway in order to reach the pellets. Hoarding was thus dependent on cage emergence, and Hess (10) has shown that "shyness" or reluctance to leave the home cage is often associated with a failure to hoard. The smaller number of low-protein rats emerging from their home cages over all five trials of the hoarding test may well reflect on the greater shyness or timidity of this group.

Food and water deprivation were followed by a marked increase in the number of control rats emerging from their home cages. The same increase was not apparent in the low-protein rats, and may indicate a difference in their capacity to adjust to such conditions.

The low-protein rats did not show any significant preference for the control-diet pellets in the hoarding trials. The finding is in keeping with the work of Scott and Quint (18) who found that in the rat there was "no appetite for protein as such."

Bindra and Thompson (3) and Hunt and Otis (12) have reported that emotional elimination, as observed in the modified open-field test, does not correlate significantly with timidity as measured by the time taken by rats to emerge from their cages and to reach food at the end of a runway. The timidity or shyness of the low-protein rats, and their greater emotionality, must therefore be regarded as separate traits, even if of common origin.

The greater number of erythrocytes in the low-protein rats is in keeping with the marked emotionality observed in the open-field test. Anderson and Anderson (1) have reported that the adrenal weights of male albino rats do not correlate significantly with scores of emotionality as measured by defecation. In the present study, neither defecation nor ambulation in the open field showed any significant relationship to adrenal weights.

The finding that the low-protein rats have smaller adrenals than the control rats is in keeping with the work of Sayers (17). Sayers reported that the low-protein rats had smaller adrenals than normal rats, and that they showed reduced cortical activity as indicated by the greater concentration of cholesterol. In an earlier study, Limson and Jackson (13) reported that rats retained on a low-protein diet had smaller adrenals than a control group, though the difference was not statistically significant. In the present study, the use of first-filial-generation rats may have provided conditions that accentuated adrenal atrophy.

Possibly through its effect on adrenal atrophy, the low-protein diet may influence the activity of the central nervous system. Hoagland *et al.* (11) report a slowing of EEG activity in the rat following adrenalectomy, while Nelson (16), working on young African children, has reported that the dominant EEG frequencies of children with kwashiorkor are well below the range for normal African and American children of the same age.

Rats on a low-protein diet are more prone to liver necrosis when kept under high temperature conditions (15). Naftalin also reports that these rats are more sluggish and drowsy in a high-temperature environment (70°-78°) than rats reared in cool conditions (60°-65° F or 35°-45° F). The high temperatures under which the first-generation rats were reared until weaning may have contributed to the greater timidity and the lower ambulatory scores of the low-protein group.

Seasonal changes in the incidence of kwashiorkor and other human malnutritional diseases involving a deficiency of protein have been reported, and associated with the availability of foodstuffs (4). Naftalin's findings, and the results obtained with the first generation in the present study, would indicate that not only the availability of foodstuffs but also temperature may be a factor in the production of liver necrosis and other symptoms associated with low-protein malnutrition.

The question arises as to whether the previously observed differences in "intelligence" as measured by the Hebb-Williams test (5, 6, 7) are a product of the timidity and general emotionality observed in the present study. This is unlikely, as the Hebb-Williams test requires a long period of familiarisation and training, and this, together with the setting of a training criterion in the test, is regarded as minimising the fear-producing qualities of the situation. Moreover, Das and Broadhurst (8) have shown that in rats selectively bred for high- and low-defecation scores in Hall's open-field test, emotional reactivity was orthogonal to scores on the Hebb-Williams test of intelligence.

The marked differences observed between the first-filial-generation low-protein rats and the control rats in timidity, emotionality, and intelligence, together with the changes in the adrenal glands and in the number of red blood cells, are regarded as arising primarily from an accumulated protein deficiency incurred during the pre- and postnatal periods. The extent to which the observed differences in the maternal behaviour of the parent generation have contributed to the results cannot be ascertained from the study.

While emotionality and timidity in low-protein rats have been defined and measured, it remains a matter for conjecture whether the emotionality observed in children with kwashiorkor is analagous.

F. SUMMARY

1. Parent-generation female rats were fed a low-protein diet from the age of 35 days. The maternal behavior of these rats was compared with normal controls with respect to their nest building, frequency of suckling, retrieving, reluctance to leave the nest, delay in returning to the home cage, and behaviour on returning to the litter. The litters of the parent generation were tested for emotionality, timidity, and hoarding. At 250 days of age, red and white blood cell counts were taken, and the adrenal glands were weighed.

2. In the parent generation, the nests of the low-protein rats were rated as more insulated than those of the control. The time delay in returning to the home cage was longer in the low-protein rats. No other significant differences in maternal behaviour were observed.

3. First-filial-generation rats were more emotional, more timid, and hoarded less than comparable control rats.

4. The adrenal glands of the first-filial-generation low-protein rats were lighter, and the number of erythrocytes was greater in the low-protein group than in the control group.

5. The marked differences in behaviour between the low-protein and the control rats of the first filial generation are attributed primarily to the effects of the low-protein diet.

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THE CONTROL OF BEHAVIOR OUTPUT AS RELATED TO THE CONCEPT OF ACTIVATION*[1]

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A. Production

The concept of "activation" in relation to behavioral efficiency or to the rate of behavior output has been reviewed recently by Malmo (2). His treatment of the concept suggests that rate of behavior output may be considered to depend in part upon activation level which is present in the responding organism during the period of response production. Thus, Malmo reasons that both high and low levels of activation will be related to less than optimal levels of performance.

Heistad (1) has presented data concerning the effects of chlorpromazine and electroconvulsive shock (ECS) on a conditioned emotional response (CER). ECS and chlorpromazine were shown to disrupt the CER. Heistad views the response level in a given situation (in his report, an emotional response) to be a function of the total stimulus complex. That is, a response learned in the presence of one stimulus complex will have a lower probability of being evoked in the presence of a second stimulus complex which differs from that under which the response was acquired. Of special interest here is Heistad's emphasis regarding the internal physiological state as an integral and important part of the stimulus complex to which responses are learned.

Under certain conditions both an activation hypothesis and Heistad's more conventional point of view would lead to similar predictions. An example of this would be as follows: When an S is trained to respond at a certain rate in the presence of a given stimulus complex, part of which is a moderate level of activation as indicated, for instance, by heart rate, that S will respond differently (at a lower rate) under different conditions, a part of which different conditions is a higher or lower level of activation. Under such conditions the same prediction would be entirely consistent with both Malmo's position as well as with that elaborated by Heistad.

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* Received in the Editorial Office on February 27, 1962. Copyright, 1964, by The Journal Press.

[1] For the purposes of this report Malmo's brief characterization of the concept will suffice: ". . . in using the term 'activation' I am referring to the intensity dimension of behavior. 'Arousal' is often used interchangeably with activation; and level of drive is a very similar concept. For instance, a drowsy S is low, an alert S is high in activation."

There are other conditions, however, under which such agreement is not found between the two theoretical positions. Consider now the case in which an *S* is trained to respond in the presence of a stimulus complex, part of which is a low (or high) level of activation, and is later tested under conditions which are similar except that at the time of the test the *S*'s level of activation is neither high nor low, but is moderate (between the high and low levels). Further, consider that the *S* is trained in the presence of a low level of activation, and tested, not under a moderate level of activation, but while highly activated.

Following a stimulus-complex line-of-reasoning, one would predict that an *S* trained in the presence of a low level of activation would perform less well in the presence of a different stimulus complex, in this case consisting in part of a moderate degree of activation. Further, the *S*s would respond even less adequately under conditions involving a high level of activation, reflecting the even greater dissimilarity between the stimulus conditions which obtained at the time of training and at the time of testing.

An activation framework would not lead one to these same predictions. Rather, when tested under a moderate level of activation, the *S* trained under a low level of activation would be predicted to respond better, more rapidly, or more efficiently than during his training period. In addition, the same *S*, when tested under a high level of activation, would be predicted to respond in a manner more similar to his behavior during training than to his behavior under a moderate level of activation.

B. Method

Eleven naive male Holtzman Sprague-Dawley albino rats between 60 and 70 days of age at the start of the study were used.

All animals were placed on a 23-hour food-deprivation schedule. Six of the animals (Group I) received a .1-cc intraperitoneal injection of saline on alternate days. On each injection day and immediately following the injection these *S*s were placed in a Skinner box for five minutes where bar pressing was 100 per cent rewarded with food. The remaining five *S*s (Group II) were each given an intraperitoneal injection of 2.5 mg/kg of chlorpromazine in a .1-cc saline solution just prior to being placed in the Skinner box.

When the average response rate for both groups appeared to have reached asymptotic levels, the contents of the injections were changed. The animals trained under saline were given 2.5 mg/kg of chlorpromazine, and the *S*s trained under chlorpromazine received 0.1 cc of saline.

On the following two running days all *S*s were run under the conditions which prevailed during their training.

Animals in both groups were then injected with .02 mg/kg of epinephrine immediately prior to being placed in the Skinner box. The following running day all animals were injected with the solutions they had received during their original training.

In addition, the response rates following 0.2 mg/kg and 0.4 mg/kg of epinephrine were determined on the next two consecutive running days.

C. RESULTS

Mean bar-pressing rates for the two groups of animals on each day's run are plotted in Figure 1.

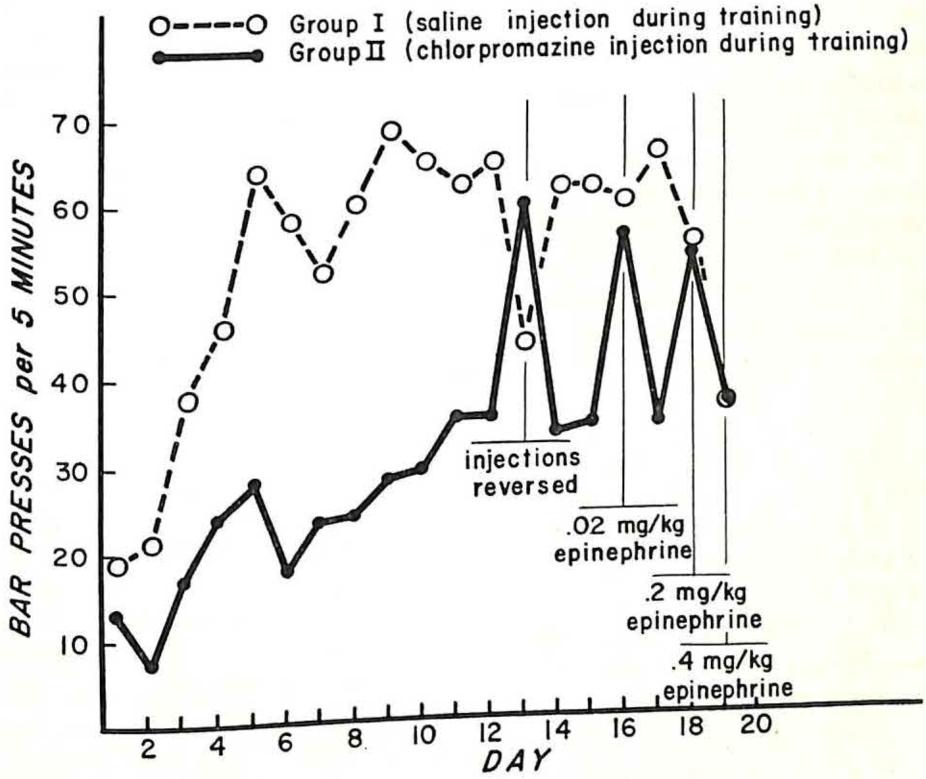

FIGURE 1
BAR-PRESSING RATES

The mean number of bar presses for the two groups were significantly different from each other on all days on which one group received saline and the other chlorpromazine.

On day 13, when the injection contents were changed, the mean response rate of Group I dropped to a significantly lower level ($p = .02$). The average response rate for Group II increased significantly, however ($p = .01$).

On day 16 the administration of .02 mg/kg of epinephrine did not produce a significant decrement in bar pressing in Group I, although there was an observable reduction in the mean value. The injection of animals in Group II with .02 mg/kg of epinephrine was followed by a highly significant increase over their training level of bar pressing ($p = .01$).

On day 18, following .2 mg/kg of epinephrine, there was a slight decrease in the average bar pressing in Group I ($p = .10$) and a significant increase over training level of bar pressing in Group II ($p = .02$).

On day 19, when all subjects were given .12-cc intraperitoneal injections of 0.4 mg/kg of epinephrine, the average response rates of the two groups were not significantly different from each other. Furthermore, they were not significantly different from the general level reached by Group II while under chlorpromazine. They were, nevertheless, both significantly lower than the level reached by Group I under saline ($p = .01$).

D. Discussion

All of the results obtained from Group I in this study could reasonably be predicted if one were to work from either an activation hypothesis or stimulus-complex notion.

The stimulus complex to which Group I was exposed during training was changed in part when, on day 13, those animals received chlorpromazine instead of the usual saline. The internal state which is assumed to be part of the total stimulus situation was also modified when, on day 19, 0.4 mg/kg of epinephrine was substituted for the saline.

Similarly, 0.2 mg/kg of epinephrine produced a change in the internal state of the animals in Group I, thus also leading to a reduction in bar pressing.

These Group I data, however, are equally consistent with the predictions which follow from Malmo's discussion of the concept of activation. Data have been presented elsewhere (3) which indicate that chlorpromazine (5 mg/kg) significantly reduces heart rate, and epinephrine (0.4 mg/kg) produces a significant increase in heart rate in rats pressing a bar for food in a Skinner box.

In terms of an activation hypothesis, the elevated heart rate in response to epinephrine and the reduced heart rate following chlorpromazine are indicants of relatively high and low levels of activation respectively. Thus, the lowered number of bar presses in Group I in response to both 2.5 mg/kg of chlorpromazine and 0.4 mg/kg of epinephrine are consistent with the predicted effects of higher-than-optimal and lower-than-optimal activation levels respectively.

The performance of the Group II animals, however, was not consistent with both theoretical positions.

In the case of the Group II animals, performance improved when saline was substituted for 2.5 mg/kg of chlorpromazine. Thus, the change in stimulus complex resulting from the change in the internal state of the animals did not produce a decrease in behavioral efficiency or output, as should be expected from a stimulus-complex frame of reference.

Furthermore, Group II performance was not changed in response to 0.4 mg/kg of epinephrine, and it improved following 0.2 mg/kg of epinephrine. Certainly, the changes in internal state which occur following the administration of 0.4 mg/kg of epinephrine to *S*s which have previously learned to respond in the presence of the effects of 2.5 mg/kg of chlorpromazine should be sufficiently great to reflect the importance of the internal state as part of the stimulus complex.

The data from Group II would seem to offer strong support for an activation hypothesis.

These results are clearly predictable from an activation framework if one accepts the proposition that the physiological effects of the doses of epinephrine and chlorpromazine employed result in levels of activation which are opposite but functionally equidistant from the "optimal" level of activation.

Now the results obtained on days 16 (.02 mg/kg of epinephrine) and 18 (0.2 mg/kg of epinephrine) can be seen to be consistent with an activation hypothesis while they are incompatible with a stimulus-complex formulation. If one conceptualizes the inverted U-shaped relationship which is said by Malmo to obtain between level of activation and behavior output, the minor doses of epinephrine can be viewed as producing levels of activation which are intermediate between the saline condition and the 0.4-mg/kg epinephrine condition. Thus, they would be expected to be associated with slightly lower response rates for the Group I animals. Similarly, the minor doses of epinephrine resulted in levels of activation which were closer (absolute distance, direction ignored) to optimal than the training condition for the Group II animals. In Group I, .02 and .2 mg/kg of epinephrine were associated with response rates higher than those which were observed under chlorpromazine.

E. SUMMARY

Rats were trained to press a bar for food reward in a Skinner box immediately following an intraperitoneal injection of either 0.1 cc of physiological saline (Group I) or 2.5 mg/kg of chlorpromazine (Group II). The reversal of the contents of the injections was followed by a significant reduction in response rate in Group I, and a significant increase in response rate in Group II. When 0.4 mg/kg of epinephrine was administered to both groups of animals, those in Group I responded at a significantly lower rate than they had under saline and *S*s in Group II continued to respond at the same rate they had shown under chlorpromazine. Lesser doses of epinephrine produced decrements in the response rates in Group II animals.

These data were offered as additional support for an activation hypothesis which holds that the relationship between behavior output and level of physiological activation or arousal is an inverted U-shaped function.

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PARENTS' ACHIEVEMENT ATTITUDES AND THEIR BEHAVIOR WITH THEIR CHILDREN IN ACHIEVEMENT SITUATIONS*[1]

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A. INTRODUCTION

In most instances in which parents are subjects in psychological research, the purpose of investigation is to study ways in which they influence their children. Sometimes this is done by examining the effects of parents' actions on the behavior of their children, and sometimes by exploring general relations between parents' attitudes, values or personality characteristics and child behavior. Several recent studies, in contrast, have concentrated on parents themselves, and sought to elucidate relationships between parents' personality characteristics and their philosophy of child rearing or their behavior with their children without also investigating the impact of these attitudes or behaviors on their offspring. This emphasis on parents per se seems desirable, apart from the value it may have in helping to understand the ways parents feel and behave toward their children, since it also offers an opportunity to determine how general personality characteristics of adults are expressed in specific actions.

Studies dealing with relations between parents' characteristics and their approaches to their children have usually employed broad personality variables or predictor variables. Several studies, for example, have investigated parents' authoritarian and ethnocentric attitudes and the association of these with child-rearing attitudes (4, 6, 8). In addition, needs of adults for achievement, aggression, nurturance, affiliation, dominance, and autonomy have also been correlated with their child-rearing attitudes and parental behaviors (1, 2, 8). The present study deals with relations between the attitudes of parents and their reported behaviors with their children in respect to one specific need system—the need for achievement. As part of a larger project

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investigating the influences of parents as identification models and as social reinforcers of children's achievement development, this study focuses on the degree to which the attitudes of parents concerning their own achievement efforts are expressed in their actions with their children in everyday achievement situations. In this investigation, achievement activities were subdivided into four areas in terms of the nature of the behaviors involved. The four areas were (*a*) intellectual achievement—activities which emphasize learning, reasoning, memory and the use of symbols (e.g., reading, taking courses, discussions of current events and other intellectual subjects); (*b*) physical-skills achievement—activities such as athletic games and sports which chiefly necessitate gross motor coordination (e.g., bowling, golf, swimming, skating); (*c*) artistic achievement—activities which stress esthetic self-expression and esthetic discriminations (e.g., music, art, and dramatics); (*d*) mechanical achievement—activities which require fine motor coordination and the use of tools, machines, etc.

B. METHOD

1. *Subjects*

The sample consisted of 40 pairs of parents of early-grade-school-age children; 20 of the children were boys and 20 were girls. The families resided in southwest Ohio, and the majority lived in villages with populations of less than 10,000. As assessed by Hollingshead's Two Factor Index of Social Position (8), the socioeconomic levels of these families represented all classes except the lower-lower class. The educational backgrounds of both parents and the vocational status of the fathers were higher than current national norms. Approximately one-half of the fathers and one-fourth of the mothers were college graduates. The mothers were about equally divided between those who were full-time housewives and those who had some full- or part-time outside occupation. The children of the study were distributed equally in the first, second, and third grades at the beginning of the study. These children were intellectually superior to national norms; their mean Stanford-Binet *IQ* was 124, with an *SD* of 16.

2. *Assessment Procedures*

The parents were interviewed on two separate occasions. To eliminate possible communication between husband and wife, each set of parents was seen simultaneously, but separately. All mothers were interviewed by the second author of the study, and all fathers by the first author. Interview A, which dealt with the parent's attitudes and behavior concerning *his child's* *achievements*, was conducted during the initial meeting; and Interview B, which focused on *the parent's own achievement* needs and behaviors, was conducted approximately one year later. During Interview A, each parent was also administered a questionnaire pertaining to his characteristic reactions to his child's achievement performances.

Interview A was a semistructured interview covering two broad topics: first, the parent's attitudes regarding his child's achievement efforts and, second, the parent's reported behavior with his child in a variety of achievement situations. Only data on the latter, as these relate to the parent's own achievement needs and attitudes, will be considered in this paper. Other studies of the current project assessing relations between parents' attitudes and behaviors and children's achievement propensities have been reported elsewhere (3, 7). In the current investigation, the four achievement areas (intellectual, physical skills, artistic, and mechanical) were discussed separately with the parent after the interviewer defined the achievement area under consideration. Data were obtained in Interview A relevant to the parent's behavior with his child in achievement situations for two parent-behavior variables, participation and instigation. Data for the third parent variable, total reactivity, were obtained by the questionnaire mentioned earlier.

The variable *Parental Participation* referred to the extent the parent was active with his child in experiences in each achievement area. This variable included the frequency of the parent's participation, the regularity with which it occurred, and the parent's personal involvement during participation. *Parental Instigation* focused on the parent's attempts to foster his child's interest and participation in an achievement area. This variable was based on the frequency and intensity of the parent's reported efforts to increase his child's interest and competence. Some examples of parental instigation are (*a*) the parent arranging for his child to receive lessons in an achievement activity; (*b*) the parent explaining to his child the value of developing a particular achievement skill; and (*c*) the parent encouraging or demanding that his child participate, practice, or show interest in an achievement activity. Parental reactions of praise and criticism *following* the child's achievement performances were not rating referents for this variable unless they indicated an intent on the part of the parent further to promote the activity in which the child was engaged. (Praise and criticism were referents for the third parent-behavior variable, *Total Reactivity,* which follows.)

A multiple-choice questionnaire was designed to assess the parent's reported reactions to his child's achievement behaviors. Each item of this questionnaire described a typical situation in which a parent might make an evaluative response to his child's achievement performance. The description of the situation was followed by a number of alternatives from which the parent was asked to select the two which were most typical of his responses to his child in situations similar to each of those described. The number of alternatives to each item included two or three reactions of a positive nature (e.g., "I told him he did a good job" and "I told him I was very pleased and expressed affection to him"), and two or three negative ones (e.g., " I told him he still needs to work a little harder" and "I told him he didn't do very well"). In addition, each item had one alternative which described a neutral reaction or nonreaction on the part of the parent (e.g., "I didn't say anything about it" or "I ignored it"). The questionnaire included 12 items (situations) for each of the four achievement areas under investigation. For purposes of the present study, the questionnaire responses were used to determine the *Total Reactivity* of the parent to his child's achievement efforts in each achievement area. The parent's score for this variable was obtained by adding the total number of positive *and* negative alternatives the parent selected within an achievement area.

The second interview with the parents, Interview B, dealt with the parent's own achievement attitudes and behaviors, and was divided into the same four achievement areas (intellectual, physical skills, artistic, and mechanical) as Interview A. Four variables in each achievement area were assessed. These variables follow.

a. Attainment value. This refers to the degree of importance placed on being able to perform competently in an achievement area. Ratings regarding this variable were based on the parent's statements concerning the reasons he participated or would like to engage in an achievement activity, the amount of time and effort he devoted to this activity in comparison with other interests and activities, and his direct comments regarding the importance of being competent in this activity.

b. Expectancy. This is the level of competence at which the parent expects he characteristically is able to perform in an achievement area. The variable was rated from the parent's evaluations of the competence of his performances, taking into account the complexity and difficulty of the tasks he reported performing. When the parent's participation in an area was minimal, he was also asked how well he would anticipate performing if he were to engage in the activities under consideration.

c. Minimal standards. This variable is that level of competence which the parent feels he must attain to be more satisfied than dissatisfied with his achievement performances. An individual's minimal standard represents the cutting point above which his competence leaves him satisfied with his own performance, and below which he feels dissatisfied with his efforts. The parent who sets high standards will be satisfied only with superior performance; anything below this will result in dissatisfaction. In contrast, the parent with low minimal standards is more easily satisfied. This variable was rated from the direct statements of the parent regarding the standards he sets for himself in various achievement activities, as well as from his reports of feelings of satisfaction or dissatisfaction when he had performed at different levels of competence. The *amount* of his expressed satisfaction or dissatisfaction was not a referent for this rating.

d. Satisfaction-dissatisfaction. This is the relative amount of satisfaction *vs.* dissatisfaction the parent expressed regarding his achievement efforts in a given achievement area. In other words, this variable referred not only to the frequency of experienced satisfaction or dissatisfaction, but also to the intensity of the parent's feelings. An average rating represented approximately equal feelings of self-satisfaction and dissatisfaction; an above average rating represented greater general satisfaction than dissatisfaction; and a below average rating, greater dissatisfaction.

Interview A was rated by the third author from verbatim typescripts. Interrater reliabilities for Interview A were evaluated from the ratings of the first and third authors on 20 randomly selected cases of the mother interviews and the ratings of the second and third authors on 20 of the father interviews. Interview B was rated by the interviewers, the second author rating the mothers' interviews and the first author those of the fathers. Two additional persons were the reliability raters for Interview B; one rated 20 of the mother interviews, and another rated 20 of the father interviews. These ratings were made from electrical recordings of the interviews.[2] Interrater reliabilities for Interviews A and B are presented in Table 1. All correlations in this table, and in those tables that follow, are rank-difference coefficients. The first two variables listed in each achievement area in Table 1 pertain to the parents' behaviors with their children as elicited in Interview A. The remaining four variables in each area are concerned with the parents' attitudes toward their own achievement behaviors as these were assessed in Interview B.

3. *Hypotheses of the Study*

Predictions concerning relations between the parents' own achievement attitudes and their behavior with their children in achievement situations

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[2] Dr. Frances Lemcke was the reliability rater for the father interviews, and Mrs. Marion Freeman was the reliability rater for the mother interviews of Interview B.

TABLE 1

Interrater Reliabilities of Parent Interviews A and B

	Mothers	Fathers
Intellectual-achievement area		
Instigation	.63	.76
Participation	.70	.84
Attainment value	.96	.87
Expectancy	.94	.90
Satisfaction-dissatisfaction	.88	.63
Minimal standards	.91	.81
Physical-skills-achievement area		
Instigation	.53	.70
Participation	.83	.73
Attainment value	.95	.94
Expectancy	.84	.91
Satisfaction-dissatisfaction	.85	.65
Minimal standards	.83	.79
Artistic-achievement area		
Instigation	.86	.72
Participation	.87	.78
Attainment value	.93	.63
Expectancy	.96	.85
Satisfaction-dissatisfaction	.93	.66
Minimal standards	.95	.89
Mechanical-achievement area		
Instigation	.69	.83
Participation	.74	.93
Attainment value	.96	.91
Expectancy	.94	.79
Satisfaction-dissatisfaction	.90	.83
Minimal standards	.89	.66

were based on two broad assumptions: These pertain to (*a*) the parent's *own needs;* and (*b*) his perception of his *role as a parent*. The first assumption argues that parents bring to any social situation, including interactions with their children, certain generalized propensities and typical ways of behaving. As a result, general predictions might be made from the parents' own achievement attitudes to their behaviors in parent-child interactions. For example, the higher the value a parent places for himself on performing competently in an achievement area, the more responsive he is likely to be to his child's interests and efforts in that achievement area. Also, the greater the satisfaction a parent realizes from participation in an achievement activity, the more time he is likely to spend in that activity with his child. The second principle guiding the formulation of hypotheses in the current study was that many of the parent's actions with his child will be determined by his perception of himself in the parental role. One such parental-role influence is that parents often view their offspring as extensions of themselves, and consequently deal with their children as though they possess many of the same needs, aspirations, and standards as the parents themselves do. Another common process in many parent-child interactions is for the parent to adopt the role of teacher or model for his child. Thus, the parent's actions are likely to be guided by the impact he believes they will have on his child, and he is likely to try to promote behavioral characteristics in his child which he himself views as favorable, and to attempt to diminish unfavorable ones. The above two influences may sometimes work together and sometimes be in opposition to each other. However, for the behaviors to which the following hypotheses apply, a parent's own needs and his parental-role behavior generally seem to be more compatible than incompatible.

Four main hypotheses were tested in the study—one pertaining to each of the four parent attitudes investigated (i.e., attainment value, expectancy, minimal standards, and satisfaction-dissatisfaction). As will be seen, each of these hypotheses contains three or more subhypotheses dealing with relations between the parent attitude under consideration and those specific parent-behavior variables for which the writers felt hypotheses might be made. In the case of Hypothesis I, it was predicted that all of the behaviors investigated would be positively associated with the parental attitude; for the other general hypotheses, fewer subhypotheses could be made.

a. Hypothesis I. A parent's *Attainment Value* for his own achievements in an achievement area will be positively correlated with (*a*) his participation in activities with his child in that area; (*b*) his instigation of his child's behavior in the area under consideration; and (*c*) his total reactivity to his child's performances in that area. It seems likely that a parent who places a high value on competence for a particular achievement skill for himself will be more sensitive to stimuli associated with that skill, and thus be more concerned with, and responsive to, his child's performances in similar achievement activities than will a parent who places little value on such activities and skills. Moreover, the parent who places high attainment value on his own achievement endeavors is apt to believe that the development of similar skills is in his child's best interest. Therefore, in his tutorial parental role, that parent is likely to do whatever he can to encourage his child's participation. Finally, it seems probable that a parent who values achievement competence will participate more frequently with his child in an achievement area than a parent with low attainment value in order to promote his child's competence and/or as an expression of his own need to perform competently in such activities.

b. Hypothesis II. A parent's own *Expectancy* of success in an achievement area will be positively related to that parent's (*a*) participation with his child; and (*b*) his instigation of his child's activities in that achievement area. This hypothesis is based on the following considerations. First, the more successful a parent expects to be in an achievement activity, the more likely he is to choose to participate in that activity in general, whether he is participating with his child or with others. Second, he is apt to participate in achievement experiences with his child, and encourage and promote his child's participation, as a function of his identification with his child. Since he—the parent—feels successful in these activities, he is likely to assume that his child, once he develops competence, will also become successful and derive satisfactions similar to those that he, himself, experiences.

c. Hypothesis III. The height of a parent's own *Minimal Standards* in an achievement area will correlate positively (*a*) with his instigation of his child's activities in that area; and (*b*) with his total reactivity to his child's actions in achievement situations representing that area. This hypothesis is based chiefly on the assumption that parents often react to their children as extensions of themselves. The parent with high standards for himself is likely to demand that his child hold similar standards, and consequently is apt to urge his child to participate in the activity in order to develop the competence necessary to meet such standards. In addition, the parent who maintains high standards for himself with respect to a particular achievement activity is likely to be more sensitive to the quality of both his, and his child's, performances in that activity than a parent with low standards, and is therefore apt to be more reactive to his child's efforts.

d. Hypothesis IV. The more *Satisfaction* a parent feels regarding his own competence in an achievement area, (*a*) the more he is likely to participate with his child in activities in that area; and (*b*) the greater probability there is that he will encourage and instigate his child to perform competently in such endeavors. The parent who derives satisfaction from his own performance, it is assumed, will want his child to participate in similar activities so that he may also gain satisfaction from them. For this reason, such a parent is apt to encourage his child's interest and participation in achievement experiences from which he himself has derived personal satisfaction. Also, the parent who gains satisfaction from his experiences in an achievement area is likely to participate in similar activities with his child, either for his own satisfaction *per se* or to encourage his child's gaining similar satisfactions.

C. RESULTS

Data pertaining to Hypothesis I, which predicted positive relations between parents' own *attainment values* and their actions with their children, are presented in Table 2. In Table 2, and in all tables that follow, correlations are presented separately for boys and for girls, as well as for the total group of children. The most consistent support for the hypothesis was found with regard to the fathers' own intellectual-attainment values and their behavior with their children in intellectual-achievement situations. The greater the importance the fathers attached to intellectual achievement for themselves, the more they participated with their sons and daughters in intellectual activities, and the more they instigated this type of behavior. A weaker trend was also present for fathers with high intellectual-attainment values to react more often to their children's performances in intellectual situations than fathers who did not value intellectual competence as highly. Mothers were found to express their intellectual values in their behaviors with their daughters, but not with their sons; the more the mothers valued intellectual achievement for themselves, the more they took part in, and reacted to, their daughters' intellectual endeavors.

TABLE 2
RELATIONS BETWEEN THE PARENTS' OWN ATTAINMENT VALUES AND THEIR BEHAVIORS WITH THEIR CHILDREN IN ACHIEVEMENT SITUATIONS*

	Parent behaviors								
	Participation			Instigation			Total reactivity		
	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Mothers									
Intellectual	*.46*	.13	*.29*	.22	—.19	.02	*.40*	—.29	.05
Physical skills	.04	*.48*	*.26*	.10	*.58*	*.29*	—.07	*.53*	.18
Artistic	.14	.03	.09	.22	.16	.18	—.01	—*.42*	—*.26*
Mechanical	—.19	.11	—.07	.03	—.30	—.16	.25	*.50*	*.39*
Fathers									
Intellectual	*.53*	*.41*	*.48*	*.44*	*.53*	*.49*	.33	.18	*.35*
Physical skills	.34	.16	.25	.14	.00	.05	.30	.10	.19
Artistic	*.49*	.14	.35	*.38*	.30	*.30*	*.43*	—.13	.15
Mechanical	.00	.27	.16	—.26	.29	.07	.16	.09	.09

* All correlations significant at or beyond the .05 level (one-tailed test) have been italicized.

In the physical-skills-achievement area, the mothers' own values were expressed in their behavior with their sons, but not with their daughters. Consistent with Hypothesis I, those mothers who considered physical prowess important for themselves, initiated, participated in, and reacted to, the physical-skills activities of their sons more often than mothers who attached little value to their own physical-skills accomplishments. None of the correlations between the physical-skills-attainment values of fathers and their behaviors with their children in physical-skills-achievement activities was significant. Apparently, factors other than the fathers' own values for themselves determined how they reacted to their children's physical-skills performances.

The findings in the artistic-achievement area were opposite—as far as sex-of-parent and sex-of-child relationships were concerned—to those obtained in the physical-skills area. Here the fathers' own artistic values were related to their behavior with their daughters, but not with their sons; while the artistic-attainment values of the mothers had little to do with their behavior with their children in everyday artistic situations. In fact, two of the correlations between the mothers' own artistic-attainment values and their total reactivity to their children's artistic efforts were significantly negative, indicating that mothers who attached a great deal of importance to artistic achievement for themselves reacted less to their children's artistic efforts—especially those of their sons—than mothers who were less concerned with artistic achievement for themselves.

Few significant relations were found in the mechanical-achievement area between the parents' own attainment values and their behaviors with their children. The correlations which were significant suggested that the higher a mother's mechanical-attainment value, the more likely she was to react to her son's efforts along mechanical lines.

In summary, two general trends are apparent in the data of Table 2. The first is that more significant relationships were found in the intellectual area than in the other achievement areas studied. In part, this finding may be a function of the particular sample of this study. Since the educational and vocational levels of the parents exceeded national norms, it seems likely that the intellectual-achievement area was more important to them than the other achievement areas studied (i.e., physical-skills, artistic, and mechanical). Because of the importance of intellectual achievement to this group of parents, their attitudes may have had more consistent and more direct expression in their behaviors with their children in the intellectual-achievement area than in those achievement areas which are of less importance to them. A second trend noted in the data of Table 2 was that mothers' values were more often associated with their behavior with their sons than with their daughters, while the opposite was true with the fathers. Moreover, these cross-sex relationships were more frequently present in achievement areas which are associated with prevailing cultural stereotypes regarding sex roles. For example, it generally is considered more appropriate for girls to excel in artistic activities than for boys to do so, and for boys to excel in physical-skills activities more than girls. It may be that the opposite-sex parent is more sensitive than the same-sex one to cultural stereotypes regarding children's sex roles, and places a greater value on helping his child assume sex-appropriate behaviors. Congruent with this was the fact that the fathers did tend to express their artistic values in activities with their daughters more than with their sons; and mothers translated their own physical-skills values into activities with their sons more than with their daughters.

Table 3 presents data relevant to Hypothesis II concerned with parents' *expectations of success* in achievement situations. Some support was found for the first part of this hypothesis, that the more successful a parent expects to be in an achievement activity, the more likely he is to participate in similar activities with his child. However, little evidence exists in the data to support the prediction that parents with high expectations of success in an achievement area will be more likely to instigate their children toward achievement activities in that area; none of the correlations between expectancy of success and instigation for mothers was significant, and only two pertaining to fathers reached a statistically significant level. These exceptions were that fathers with high success expectancies in intellectual and artistic activities tended to instigate the behavior of their children in these areas more than fathers with low expectations of success.

TABLE 3
RELATIONS BETWEEN THE PARENTS' OWN EXPECTANCIES OF SUCCESS AND THEIR BEHAVIORS WITH THEIR CHILDREN IN ACHIEVEMENT SITUATIONS*

	Parent behaviors					
	Participation			Instigation		
	Girls	Boys	Total	Girls	Boys	Total
Mothers						
Intellectual	*.39*	.08	*.26*	.29	—.10	.13
Physical skills	.21	*.44*	*.29*	.05	—.07	.02
Artistic	.05	.04	.04	.37	—.07	.13
Mechanical	—.02	*.42*	.22	.13	.02	.06
Fathers						
Intellectual	*.43*	.30	*.35*	.34	.36	*.38*
Physical skills	.31	*.48*	*.34*	—.09	—.08	—.11
Artistic	*.46*	.26	*.44*	.34	.20	*.27*
Mechanical	—.06	*.62*	.23	—.02	.09	.05

* All correlations significant at or beyond the .05 level (one-tailed test) have been italicized.

The data on the parents' expectations of success and their participation with their children in achievement situations again indicate variations based on sex of child. In contrast to the attainment value–parental behavior relationships, however, the sex of the parent does not appear as important since similar trends existed for *both* mothers and fathers. Both parents expressed their own expectancies for success by participating more frequently in activities with their children in accord with culturally defined sex-role interests. Thus, the greater the expectations of success of both mothers and fathers in physical-skills and mechanical activities, the greater their participation with their sons in these types of activities. And with respect to their daughters, fathers and mothers who are confident of their own intellectual competence were more likely to participate in activities representing this area than parents with low expectancies for success. In addition, significant positive relations were found between the fathers' expectations for success in art and their participation in, and instigation of, artistic activities of their children, particularly their daughters. The different patterns of correlations found by sex of child may indicate that the freedom with which parents express their own confidence or lack of confidence in their behavior with their children in an achievement activity depends on the sex-role definition which society gives a particular type of activity. For example, the data indicate that parents who believe themselves competent in physical skills readily participate with their sons in sports and other gross motor activities, while parents who regard themselves as less competent refrain from such participation with their sons. In contrast, the parents' personal feelings of competence play little part in the frequency of their physical-skills participation with their daughters. It may be that since American society does not place as much emphasis on physical-skills achievement for girls as for boys, the parents are less concerned with their own competence when participating in physical activities with their daughters and other nonachievement variables are of more importance in influencing the frequency of parental participation.

Concerning Hypothesis III, the correlations shown in Table 4 indicate that mothers with high personal *minimal standards* in physical-skills and mechanical-achievement activities reacted more frequently to the efforts of their sons in these areas than did mothers with low personal minimal standards. However, none of the relations between the mothers' minimal standards and their participation with their children in achievement situations was statistically significant. The minimal standards of fathers, on the other hand, were positively associated with their participation in some of the achievement areas, but were not related to their frequency of reacting to the achievement behaviors of their children. The higher the fathers' intellectual minimal standards for themselves, the more often they took part in intellectual activi-

TABLE 4

RELATIONS BETWEEN THE PARENTS' OWN MINIMAL STANDARDS AND THEIR BEHAVIORS WITH THEIR CHILDREN IN ACHIEVEMENT SITUATIONS*

	Parent behaviors					
	Participation			Total reactivity		
	Girls	Boys	Total	Girls	Boys	Total
Mothers						
Intellectual	.36	.07	.20	.20	—.21	—.02
Physical skills	—.17	.23	.05	.01	*.39*	.18
Artistic	.00	.05	.02	—.16	—.18	—.22
Mechanical	—.21	.20	.10	.11	*.47*	*.33*
Fathers						
Intellectual	*.43*	*.40*	*.42*	.23	.01	.21
Physical skills	.23	.10	.16	.01	—.13	—.02
Artistic	*.38*	.22	*.34*	.34	—.01	.20
Mechanical	.05	.26	.17	.07	—.04	.04

* All correlations significant at or beyond the .05 level (one-tailed test) have been italicized.

ties with their offspring. Also, fathers who held high artistic standards for themselves were more likely to participate in artistic activities with their children, particularly their daughters, than were fathers with low artistic standards.

In general, the findings pertinent to Hypothesis III suggest that when mothers and fathers express their own minimal standards in their behavior with their children, they are likely to do so in different ways. Fathers who demand a high level of performance from themselves are more likely to *participate* with their children in achievement activities than fathers who are more easily satisfied. The motivation promoting the fathers' participation may be the desire to foster the competence of his child and/or to practice, himself, in order to demonstrate or increase his own competence. In contrast, mothers are more likely to express their personal standards by *reacting* directly to the child's efforts rather than participating with him in an activity. The mothers' motivation for doing so may be their desire to see their offspring perform as well as they would like to perform themselves. In both cases, however, the likelihood of the parents' own minimal standards influencing their actions with their children generally depends on the achievement area under consideration as well as on the sex of the parent and child. As with the findings pertaining to parents' attainment values, the relations between the parents' minimal standards and their participation with and reactivity to their children are cross-sexed and follow the cultural definitions or stereotypes of sex roles. Significant correlations were between fathers and their daughters in the intellectual- and artistic-achievement areas, and between mothers and their sons in the physical-skills and mechanical areas.

Relations between the parents' *satisfaction-dissatisfaction* with their personal achievements and their behavior with their children are shown in Table 5. Hypothesis IV, which postulated positive relations between parents' satisfaction with their own competence and their instigation and participation with their children, received only partial support. The more satisfied the mothers were with their own physical and mechanical skills, the more they participated with their children, particularly their sons, in these activities.

TABLE 5

RELATIONS BETWEEN THE PARENTS' OWN SATISFACTION-DISSATISFACTION AND THEIR BEHAVIOR WITH THEIR CHILDREN IN ACHIEVEMENT SITUATIONS*

	Parent behaviors					
	Participation			Instigation		
	Girls	Boys	Total	Girls	Boys	Total
Mothers						
Intellectual	—.20	.03	—.13	.18	—.29	—.04
Physical skills	.16	.33	*.28*	—.05	—.21	—.12
Artistic	—.06	—.17	—.13	.31	*—.42*	—.08
Mechanical	.05	*.46*	*.29*	.22	.03	.13
Fathers						
Intellectual	—.25	—.03	—.12	—.11	—.35	—.24
Physical skills	—.01	.32	.16	—.15	*—.47*	*—.30*
Artistic	—.02	—.13	—.06	.11	—.01	.01
Mechanical	.05	*.44*	.16	—.01	—.08	—.11

* All correlations significant at or beyond the .05 level (one-tailed test) have been italicized.

On the other hand, the significant correlations obtained dealing with the parents' self-satisfaction and their instigation of their children toward achievement activities were in the direction opposite to that predicted. Apparently the parent who does not derive satisfaction from his own performance in an achievement area is more likely to encourage his child's participation in such activities than the parent who is satisfied with his own performance. One *post hoc* reason for this negative relationship may be that the dissatisfied parent instigates his child's achievement activity with the hope that the child may ultimately develop more satisfying skills than the parent himself possesses. This appears to be a plausible explanation for the negative correlations between the fathers' self-satisfaction with their physical-skills achievements and their instigation of physical-skills activities on the part of their children, particularly their sons. Fathers who are not content with their own physical prowess may be all the more desirous of developing physical skills in their children than fathers who are satisfied with their own physical abilities. A similar explanation may be offered for the finding that mothers who expressed dissatisfaction with their artistic performance instigated artistic behavior on the part of their sons more than mothers who were generally satisfied with their own artistic abilities. While these *post hoc* explanations seem reasonable, they are based on relations *opposite* to those predicted and, thus, require additional confirmation or refutation in further research.

D. SUMMARY AND CONCLUSIONS

The mothers and fathers of 40 grade-school-age children were interviewed and administered a questionnaire pertaining to their behaviors with their children in four types of achievement situations: those dealing with intellectual, physical, artistic, and mechanical skills. At a later time the parents were interviewed again concerning their own achievement attitudes in the same four achievement areas. Correlations were run between the parents' reported behaviors with their children (participation, instigation, and reactivity) and four achievement variables pertaining to the parents themselves (attainment value, expectancy for performing competently, minimal achievement standards, and satisfaction-dissatisfaction with their own achievement efforts).

The following general results were obtained. First, pertaining to the parents' *attainment values*, the values the fathers held for themselves were expressed in their behavior with their children, chiefly in the intellectual-achievement area. The higher the value placed on intellectual achievement for themselves, the more the fathers participated in, instigated, and reacted to, the intellectual activities of their offspring. In addition, the artistic-attainment values of the fathers correlated positively with their participation, instigation, and total reactivity to the artistic efforts of their daughters. Mothers with high intellectual values took part in and reacted to their daughers', but not to their sons', intellectual activities more frequently than mothers with low intellectual values. In contrast, the importance mothers placed on physical-skills achievement for themselves related to their actions with their sons, but not their daughters; mothers who highly valued physical-skills competence for themselves participated in, instigated, and reacted to, the physical activities of their sons more often than mothers who did not consider physical-skills achievement important for themselves.

In general, the parents' own *expectations of success* were more often related to the extent of their participation with their children in achievement activities than to the degree they instigated or encouraged their children to engage in such pursuits. The higher both the mothers' and fathers' expectations of success in physical-skills and mechanical activities, the greater their participation with their sons in these types of experiences. In the intellectual-achievement area, the parents' own expectancies of success were also positively related to their participation with their children, particularly their daughters. Finally, fathers with high artistic expectancies for themselves also instigated and took part in the artistic efforts of their offspring, especially their daughters, more than fathers with low expectations of artistic success.

Concerning the *standards* the parents held for themselves, the minimal standards of mothers did not correlate significantly with their participation with their children, but in several instances did relate to the frequency of the mothers' reactions to their sons' achievement behaviors. Mothers with high personal minimal standards in physical-skills and mechanical activities reported reacting more frequently to the efforts of their sons in these achievement areas than did mothers with low minimal standards. In contrast, the standards of fathers were not related significantly to their reactivity to their children, but were associated with the amount of their participation with their children, particularly with their daughters, in the intellectual and artistic areas.

The greater the parents' *satisfaction* with their own achievement behaviors in the mechanical area, the more they participated in mechanical activities with their sons. In addition, the self-satisfaction of the mothers in the physical-skills area, and that of the fathers in the artistic area, correlated positively with their participation with their offspring in activities in these respective areas. However, contrary to the hypothesis made, fathers who were dissatisfied with their own physical-skills prowess instigated physical activities for their sons more than fathers who were satisfied with their own physical-skills competence. Similarly, mothers who were dissatisfied with their own artistic performances encouraged their sons more often to participate in artistic activities than mothers who were satisfied with themselves in this achievement area. These negative relationships may indicate that the dissatisfied parent instigates his child's activity with the intent of helping the child ultimately to develop more satisfying competence than the parent himself possesses.

A number of the significant relations obtained in the study followed cultural stereotypes of appropriate achievement interests and skills for boys and for girls. The parents' own achievement values, expectancies, standards, and feelings of satisfaction in the intellectual and artistic areas were more frequently associated with their behaviors with their daughters than with their sons; and in the physical-skills and mechanical areas these relations occurred more with their sons than with their daughters. Furthermore, a number of cross-sex relations following the above pattern were found; that is, the fathers more than the mothers expressed their own achievement attitudes in their behaviors with their daughters in the intellectual and artistic areas, while the mothers more than the fathers expressed their achievement attitudes concerning physical skills and mechanical activities with their sons. In general, then, there appeared to be a trend for the parents, particularly parents of the sex opposite to the child, to translate their own achievement attitudes into their behavior with their offspring in a manner consistent with cultural stereotypes of sex roles.

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SOME PROBLEMS IN PERCEPTUAL HANDICAP OF MENTALLY RETARDED CHILDREN*

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A. PURPOSE

Many writers in psychology (13, 15, 18) have noted that some retarded children have specific perceptual handicaps. Much of the literature has centered around the demonstration that this deficit was due to brain damage. A brilliant criticism of the concepts of "brain damage, exogenous and endogenous" has been made by Malamud (6). As Malamud has shown, certain destructive processes are related to the symptoms of epilepsy (7) and para and postnatal destructive processes (6). While it is not inappropriate for the psychologist to link impaired perceptual performance to certain aspects of "brain damage" and other symptomatology, it is more important for the psychologist to tie perceptual handicap to antecedents in the psychological development of the individual. Behavior, being a molar phenomenon, must be described by a psychologist not only by reference to physiology, but by reference to behavioral differences and to earlier stages of development. This requires a theory of perceptual development. One fruitful theory involves the combination of the concepts of Werner (17) with those of Friedman (3) and Phillips, Kaden, and Waldman (11).

The problem of assessing perceptual handicap in mentally retarded children below the mental age of six years has not been specifically dealt with. The detection of perceptual handicap is of considerable importance in understanding the mentally retarded child's behavior.

Many attempts have been made to describe the personality patterns of the perceptually handicapped and, in general, writers agree that the patients show less emotional control (13), overactivity, lack of attention, and other behavior problems (15).

The Rorschach Test has been evaluated in several studies with the mentally retarded (2, 12, 16). The two most pertinent studies for our purposes are those of Rosenblatt and Solomon (12) and Werner (16). The former study shows that the Rorschach responses of the mentally retarded are genetically

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more immature than would be anticipated for patients of their chronological age. The study by Werner indicates that there are certain characteristics of the Rorschach in the brain-injured child which may be interpreted as structurally lower in response and earlier in development if the Rorschach is evaluated from the point of view of Phillips, Kaden, and Waldman (11). Likewise, the study of Sarason and Sarason (13) shows certain immature elements when considered from the point of view of later work.

Peña has shown that adult patients with known organic deficits show Rorschach patterns consistent with those of children. There appears to be a specific pattern of regression in perception as shown on the Rorschach Test following brain damage in the adult person. Peña's results show further that this regression is different from regression in the functional psychosis.

Studies of this type have not been done with children of mental ages between two and six years, and no studies have been specifically oriented toward demonstrating a lack of development of certain structural aspects of the personality. It is reasonable to test the hypothesis that "higher" levels of response will develop later, if at all, in the perceptually handicapped, mentally retarded child.

This paper has set itself three tasks:

1. To determine if perceptual handicap can be demonstrated in mentally retarded children with mental ages between two and six years.
2. To relate perceptual handicap to certain aspects of medical diagnosis of mental retardation as found in the medical record and from appropriate physical and neurological examinations of the patient.
3. To assess the question of whether there is a lack of development of "higher" level responses on the personality level by the use of two personality tests (the Rorschach and the Mosaic), both of which may be scored developmentally—the former in accordance with the schemas developed by Friedman (3), Hemmendinger (4), Peña (8), Phillips, Kaden, and Waldman (11). The Mosaic can be scored developmentally according to the general schemas outlined by Lowenfeld (5).

B. Method of Experiment

In order to select two populations of patients—namely, those without perceptual handicap and those with perceptual handicap—we obtained mental-age scores in the following areas: vocabulary, completion, drawing, and block design. Discrepancy scores were obtained between a composite of vocabulary and completion items, and perceptual tasks.

As a measure of vocabulary ability, we chose picture vocabulary from forms L and M of the 1937 Stanford-Binet Scale, and an average of mental ages was obtained.

Completion-type items were obtained from a composite of tests. We selected the picture puzzles, the mare and foal, and the manikin from the Merrill-Palmer Scale. Picture completion at the three-year level was used from the Leiter International Performance Scale. From the Stanford-Binet we selected the "patience" items and the mutilated pictures. The score obtained is the highest pass before three successive failures.

Perceptual tasks were divided into two types: drawing ability and block design. It was our desire to use Bender-Gestaltlike items at lower age levels. For this reason we selected drawing items from the Gesell Developmental Series. To this we added the circle, cross, square, star, and diamond from the Merrill-Palmer and Stanford-Binet Tests, and Design "A" of the Bender-Gestalt Test scored as a success at seven years. This gave us a series of tests covering the mental-age ranges of about 13 months through seven years. This series of items has been designated as the "Drawing Maturation Scale." The score obtained is the highest pass before three successive failures.

From the subject's performance on the Leiter International Performance Scale came the second perceptual task, block design. The absence of block design at the four-year level necessitated the use of the color-form tests. This gave us a series of tasks from mental ages two to six years. The score was the highest success before two years of failure. Since the Leiter is a more difficult test, the level of performance on block design was somewhat lower than the performance on the other tests.

After the psychological testing was completed, an attempt was made to evaluate the cause of the mental retardation. All of us who helped make these evaluations knew that we were dealing with a very select population and that certain children by the very nature of the experiment are excluded from consideration. With these inadequacies in mind, however, we had the patients evaluated by two Board Pediatricians—one, the ward physician; the other, the Assistant Superintendent, Medical. The ward physician examined each patient, while the Assistant Superintendent examined the clinical record. Missing information, such as birth records, was obtained before a final decision was made as to the probable cause of the retardation. The physicians, independent of each other and without knowledge of the psychological-test results, placed each patient in one of two groups. The first group consisted of patients with characteristics of defective fetal development (some of these defects are probably of genetic origin). Nineteen patients fell in this group. Ten of them had multiple congenital defects, and had been diagnosed as mentally retarded from birth or soon afterward; the remaining nine patients had been studied in our Educational Staff Conference, and the diagnosis of mental retardation due to defective fetal development was made by the chairman of the conference after considering all the material from the various services. Fifteen cases were diagnosed as due to brain injury, stemming from birth or later in life. (The latter cases have all been seen by a Board-certified neurologist, and have also been discussed at the Educational Staff Conference.)

The Rorschach was administered in the standard manner, except that the inquiry was given following each card. The Rorschach Test is scored according to developmental level as devised by Friedman (3), and revised by Phillips, Kaden, and Waldman (11).

Our second projective device is the Mosaic Test administered in the following manner: Before each child entered the testing room, we fitted a piece of paper to the board; at the right side of the board we placed a chance selection of pieces including each color and shape. When the child was seated, the examiner handled some of the pieces, saying, "See all these things. Why don't you make something out of them?" Notes were made on the order of the designs and the process of placing the pieces on the board. The pieces on the board were traced and colored with pencils. From this record we scored the productions according to Table 1.

C. PROCEDURE

The ward of young school boys was chosen for the experiment. The children were selected in alphabetical order from the ward roster and each was given the Stanford-Binet Picture Vocabulary Tests. Children who were cooperative and who could respond verbally to the cards, and whose mental ages on this test fell at or below five years, were selected for the experiment. Following the administration of the Stanford-Binet Vocabulary Tests, the boys were given the drawing-maturation, picture-completion, Leiter, Rorschach, and Mosaic Tests—in that order. Thirty-four subjects were obtained by this method, and all but one, who was transferred to another facility before he could be given the Mosaic Test, were given the complete battery of tests. The sample consisted of boys between the ages of seven and 17 (the mean age was 14.2 years), with an average Stanford-Binet Vocabulary mental age of four years and five months. On this test their *IQ*s varied between 31 and 46; thus they were all moderately retarded on this measure of intelligence. This measure of intelligence is remarkably close to scores

TABLE 1

SCORING OF THE MOSAIC TEST*

I. *"Slab" formations*

A. Isolated pieces on tray.
B. Chance pushing of pieces together with color and form mixed.
C. Simple slab—no interest in exact correspondence of size and color, but there must be some attempt at patterning parts of design.
D. Many pieces pushed together, either by color *or* by form. (This includes edge constructions more than two deep.)
E. Prerepresentational.

II. *Fundamentals*

A. Wavering lines.
B. Square with triangle on top.
C. Two triangles put together.
D. "Kite reaction."
E. Pairs
F. Prefundamental—pattern begun with one form, but not finished. (Three or more forms the same.)
G. Fundamental.

III. *Edge patterns*

A. Any form or color placed along the edge (one deep).
B. Areas of either forms or colors placed along edge (one deep).
C. Consistent forms placed along edge (one deep).
D. Groups at edge (two deep) orderly pattern—colors and shapes used in regular way.

(Further edge patterns become either slabs or fundamentals.)

* This table contains the same material as the one by Lowenfeld (5), although some attempts were made to refine her scoring.

they had obtained on previous psychological tests; *IQ* variation was not over six points in any case.

D. RESULTS AND DISCUSSION

Clinical experience with our hospital population suggested that in this mental-age range a discrepancy of greater than one year on perceptual tasks would be a nonchance deviation, and would indicate gross perceptual handicap. That such is the case is shown in Figure 1.

The distribution of discrepancy scores indicates that the curve is distinctly bimodal. It is apparent from this curve that we are, in fact, dealing with two clinical populations. In order to describe these groups further, we ran t tests between abilities in various tasks. There is no significant difference between the groups in the combined completion and vocabulary tests (the t is 1.05). There is a striking difference between the means of the groups in the perceptual tasks. The unimpaired group has a mean of 32.13 months, which is significantly higher than the impaired group. The t of 7.52 is significant at the .001 level of confidence.

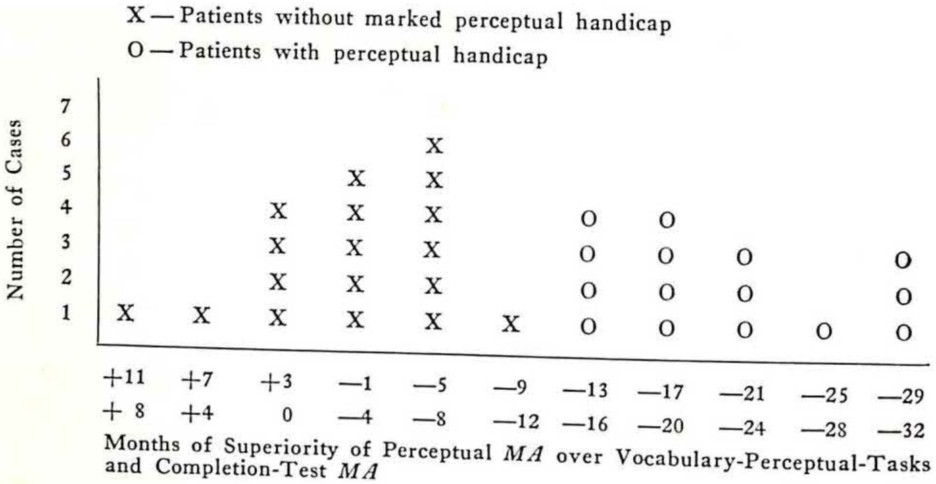

FIGURE 1
DIFFERENCE, IN MONTHS, OF VOCABULARY AND COMPLETION TASKS FROM PERCEPTUAL TASKS

The patients' medical records and examinations indicate that children with defective fetal development show no excessive evidence of perceptual handicap, while children with para- or postnatal diagnoses show perceptual impairment of a year or more. This is significant at the .01 level of confidence. A significant number of patients with perceptual defects have seizures. Inspection of the records shows that these seizures all began in the first year of life, and all were characterized by grand-mal-type convulsions. Conversely, the presence of congenital anomalies is significantly related to a generalized lower level of performance, but without evidence of impaired perceptual ability.

The results of evaluating the medical records and examinations of the patients indicate that there is a high relationship between para- and postnatal destructive brain processes and perceptual impairment.

These findings are in striking agreement with those of Malamud (6. 7). The lack of perceptual impairment is highly related to the presence of congenital anomalies, and again agrees with the findings of Malamud (6); it is known that these patients have malformations of the brain. The conclusion from this study suggests that perceptual impairment is related to destructive processes in the brain. The final relationship of perceptual impairment to specific kinds of brain destruction cannot be adequately determined until neuropathological findings are available on patients on whom these tests have been done.

TABLE 2
COMPARISON OF THE MEDICAL CHARACTERISTICS OF THE PATIENTS

Patient characteristics		No perceptual impairment	Perceptually impaired	χ^2	p
Diagnosis of defective fetal development		16	5	7.16	.01
Diagnosis of brain damage (at birth or after)		3	10		
Seizures	Present	3	9	5.37	.05
	Absent	16	6		
Congenital Anomalies	Present	9	1	4.43	.05
	Absent	10	14		

The results of the Rorschach analysis indicate that the groups are practically identical in the number of responses given, the number of determinants used, the number of populars, the color responses, and the number of content categories used. Nonperceptually handicapped children have more mediocre and more D responses than the perceptually impaired and their F+ per cent is higher. Perceptually impaired children tend to have more W responses, higher perseveration scores (9) and more F— responses. The significant differences between the groups are found in the higher number of amorphous, space, and shading responses; these responses would be scored as Clob by Ames (1). The results are shown in Table 3.

TABLE 3
COMPARISON OF PERCEPTUALLY HANDICAPPED AND NONHANDICAPPED ON RORSCHACH SCORES

Category		Without perceptual handicap	With perceptual handicap	χ^2	p
W_a	Present	3	10	7.16	.01
	Absent	16	5		
D_a and Dd_a	Present	1	7	5.85	.02
	Absent	18	8		
W, S	Present	2	11	11.47	.001
	Absent	17	4		
Shading	Present	5	11	5.67	.02
	Absent	14	4		

Our conclusion from these data is that the child with perceptual handicap is responding in a more diffuse manner to the environment, suggesting that perceptual impairment is a general reaction and is not limited to performance on measures of intelligence and "brain damage." In order to analyze the Rorschachs further, we compared our protocols with the age norms of Ames (1) and Hemmindinger (4). In general, the perceptually handicapped group gave Rorschachs very similar to normal children two-and-a-half-years old, which agrees well with their responses on the other perceptual tasks. The average of 12.3 responses per record agrees with the average of two-and-a-half- and three-year-old children as found by Ames (1) and Hemmindinger (4). The other children with a perceptual age of four years, show a decrease of W in favor of D, a finding consistent with that of Hemmindinger (4). Perceptually impaired children have lower F+ per cent than the unimpaired (at the .10 level of significance). This trend is consistent with findings by other writers who have shown that the F+ per cent increases with age (10). The perceptually handicapped give more F responses than the nonhandicapped and this, too, is consistent with age trends in normal children. Both groups have considerably more C and CF responses than FC responses. What controlling factors there are in the color responses appear more frequently in the unimpaired group. "Clob" responses are especially high for the normal two-and-a-half-year-old child, and the score "Clob" is high for the perceptually impaired group. The drop of "Clob" is characteristic of older children, and is consistent with the disappearance of amorphous, shading, and S responses found in the developmental scores of that group. As in the normal two-and-a-half-year-old child, animals form the largest single content category in handicapped children; the largest number are tame animals. The next most common category in the record of normal two-and-a-half-year-old children is plants, primarily trees; this is true of our handicapped subjects, who give 31 plant responses of which 27 are trees.

The nonhandicapped child shows content that corresponds very closely to the record of the four-year-olds. There is an increase from seven human responses in the handicapped group to 23 in the nonhandicapped child. Wild-animal responses predominate; they are more frequent than tame animals; this is a reversal from the records of the perceptually handicapped. The butterfly and bird categories come next in both the normal four-year-old child and also in the unimpaired children.

Perseveration seems to be at the expected level for perceptual age, as is the use of space. The number of S responses in the perceptually handicapped relates very nicely to the higher amount of negativism and aggression shown in normal children at the age of two-and-a-half.

Perceptually handicapped children appear to have a lower level of perceptual organization than do the nonhandicapped children of the same verbal mental age. Responses on the Rorschach Test are comparable with perceptual age rather than with other measures of intelligence; the perceptually handicapped child gives Rorschach responses comparable to those of younger children.

The Mosaic Test does not differentiate between our groups in the production of the simpler patterns. The difference lies in the fact that nonhandicapped patients make Mosaic constructions usually found in children around four to five years of age (kites, pairs, fundamentals, and prerepresentational figures). Perceptually handicapped children are not capable of producing higher-level perceptual responses. This difference has a χ^2 of 10.08, and is significant at the .001 level of probability. These findings are in agreement with those of Shotwell and Laurence (14).

E. SUMMARY

A battery of tests have been described which significantly differentiate perceptually handicapped, retarded children from other retarded children with mental ages between two and six years. An evaluation by the medical personnel of the patients and the medical history suggests—but does not prove—that perceptual handicap is significantly related to para- or postnatal brain damage, and appears to be significantly related to the development of convulsions in early life and inversely related to the presence of congenital anomalies. These findings are in agreement with those of Malamud (6, 7). The difference between the perceptually and nonperceptually handicapped group was most striking in scatter on intelligence tests. Perceptually handicapped children do significantly worse on these tests as compared with vocabulary and picture-completion-type tests.

The differences on the Rorschach Test between the two groups are consistent with the level of perceptual organization. The Rorschach responses of the perceptually handicapped child are in keeping with their perceptual age rather than with their verbal ability. These results suggest that the perceptually handicapped child sees the world as an amorphous, perceptually confusing, disorganized, conglomerate of objects rather than as an integrated whole. Perceptual defects appear to be characteristic of earlier stages of development, and this research suggests that there is failure of development in certain significant areas.

The fact that perceptual immaturity is demonstrable in various tasks—some of them closely related to personality organization—indicates the possibility that the "emotional" disturbances of the perceptually handicapped child are magnifications of his inability to grow in certain areas. The hyperactivity, lack of attention, concentration, and negativism in these children may be understood as lack of personality growth, partly based upon inability coherently to structure the environment. Understanding these children revolves around efforts to help them develop a technique for perceptually differentiating their environment, and learning with them techniques of responding to selected stimuli. Building ego strength and more adequate defenses by utilizing concrete situations and environmental simplification may be necessary techniques in therapy of the perceptually handicapped child.

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SOCIAL VALUE: SOCIAL BEHAVIOR CONSISTENCY, PARENTAL IDENTIFICATION, AND AGGRESSION IN LATE ADOLESCENCE*

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A. INTRODUCTION

The relationship between the values that adolescents hold about their interpersonal behaviors and the behaviors that they manifest has received research attention in two recent studies which found that adolescents who show less consistency between expressed social values and characteristic social behaviors tend to be more maladjusted than those who are more consistent in this regard. In a study by Heilbrun and Goodstein (11), the less consistent college group included a significantly higher proportion of *S*s who sought professional help for personal-adjustment problems. Heilbrun (10) later demonstrated with a new group that less consistent college *S*s were more anxious and schizoid as evidenced by more deviant scores on selected scales of the MMPI. Two basic questions were raised by the replicated relationship between social-value, social-behavior (SV-SB) inconsistency and early signs of psychopathology in adolescents.

One question was concerned with the nature of the conditions which antecede SV-SB inconsistency. One possible antecedent would be some difficulty in the parental identification process. Both parents to some extent (but the same-sexed parent in particular) provide a set of social values and behaviors to which the child is exposed during the developmental years. The learning of these is largely mediated by the identification process which, if successful, provides the child with a set of sex-linked values and behaviors which will meet with social sanction. However, if the adolescent has failed to identify with an appropriate parental model, his social values should tend to deviate from sexual stereotype and, consequently, meet with social disapproval. If true, SV-SB inconsistency might represent an attempt on the part of the inadequately identified adolescent to avoid social punishment by manifesting social behaviors which do meet with approval, but which are not consistent with the learned values.

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Complicating the relationship between SV-SB consistency and appropriateness of identification is the fact that an appropriately identified adolescent with socially approved sex-typed values could behave inconsistently in way of asserting independence or hostility via acting out his rejection of parental values. In such a case, SV-SB inconsistency would be associated with identification with an appropriate parental model. One of the purposes of the present study was to assess these alternative relationships between SV-SB consistency and identification.

The second question to which the present study was addressed concerned the possible role of SV-SB consistency as an intermediary factor in the relationship between identification and aggression. Bandura and Walters (2) have reported poorer identification with the father in a group of aggressive adolescent boys than in a control group. They related this to inadequate internalization of controls for the aggressive boys stemming from the poorer paternal identification. However, their failure to employ a measure of adequacy of the paternal model[1] relative to the masculine stereotype allows for a complementary, if not alternative, interpretation of their results. Although there is precedent for relating aggression in children to inadequate internal controls (e.g., 14), there has also been considerable support for frustration as an important antecedent of aggression since the early explication of the frustration-aggression hypothesis (5). The possibility remains that the aggression displayed by some of Bandura and Walter's adolescents was a function of (*a*) inappropriate identification which (*b*) resulted in socially censured interpersonal attributes which (*c*) produced frustration and (*d*) instigated aggression. The generalization which is being suggested is that any combination of identification outcome and SV-SB consistency which results in a failure to meet sex-linked behavioral stereotypes for the adolescent introduces a frustrating state of affairs induced by real or anticipated social disapproval which, in turn, instigates aggression. Thus, the inappropriately identified adolescent (male or female) who shows high SV-SB consistency, and the appropriately identified adolescent characterized by low SV-SB consistency, should show greater aggression than the inappropriately identified, low SV-SB consistency and the appropriately identified, high SV-SB consistency adolescents.

Since the frustration hypothesis, in accounting for adolescent aggression, would predict that heightened aggression would "cut across" the adequacy of identification variable as a function of SV-SB consistency rather than be negatively related to it as suggested by Bandura and Walters, an analysis of the identification-aggression relationships was included in the present study. Further, possible sex differences in all of the relationships discussed above were explored.

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[1] Bandura and Walters (2, p. 30) do acknowledge "quality of the parental model" with regard to the social acceptability of their values to be an important influence on the process of socialization.

The specific hypotheses (identical for males and females) investigated in this study were:

1. (*a*) Inappropriately identified late adolescent *S*s will show a lower SV-SB consistency than will appropriately identified *S*s (if conformity to social expectancy is more important.) (*b*) Appropriately identified late adolescent *S*s will show a lower SV-SB consistency than will inappropriately identified *S*s (if rejection of parental values is more important).

2. (*a*) Appropriately identified late adolescent *S*s will be less aggressive than inappropriately identified *S*s (if a failure in internalized controls is more important). (*b*) There will be no difference in degree of aggression between appropriately and inappropriately identified late adolescent *S*s (if the social censure→frustration→aggression sequence is more important).

3. Late adolescent *S*s for whom the SB component (of SV-SB) fails to conform to sexual stereotype and is more likely to elicit social censure will be more aggressive than those *S*s for whom the SB component is appropriate as to sex typing and less likely to elicit social censure.

B. METHOD

1. *Measure of SV-SB Consistency*

The Edwards Personal Preference Schedule (EPPS) (6) is composed of 210 items, each item including a pair of statements judged to measure different socially relevant traits. *S* is asked to select the more characteristic behavioral alternative. The statements may also be presented to *S* in unpaired form, and rated for social desirability of the behaviors described. By obtaining the performance of *S* on the EPPS and the subsequent social-desirability values he assigns to the paired statements, the per cent of times he endorses the behavior which has a higher social value for him can be determined. This SV-SB consistency score is presumed to approximate the strength of the tendency to respond to more highly socially valued alternatives in one's actual interpersonal behavior, and represents the same index used in previous studies relating SV-SB inconsistency to psychopathology (10, 11).

2. *Measure of Identification*

The psychometric index of identification was based on the assumption that an adolescent who describes his or her own personality as being more similar to that of the same-sexed parent is more highly identified than an adolescent whose self-description is less similar to the personality of the same-sexed parent. This is consistent with identification theories (13, 15, 17) which place imitation of the parental model as the key process of identification. Subjects were asked to read the descriptions [found in Edwards (6)] of the 15 traits[2] measured by the Heilbrun Need Scales (7) and to rate whether each set of behaviors better described the father or the mother. Then the standard scores of the Need Scales obtained from the same *S*s were used in combination with these forced-choice parental descriptions by giving plus credits for (*a*) each point *S* scored above 50 (the college average) on a Need Scale trait perceived as more characteristic of the same-sexed parent, or (*b*) for each point scored below 50 perceived as more characteristic of the opposite-sexed parent. Conversely, negative credits were given for (*a*) each point scored above 50 on a trait seen as more characteristic of the opposite-sexed parent, or for (*b*) each point scored below 50 on a trait seen as more characteristic of the same-sexed parent. Raw-score summations of these plus and minus credits over the 15 traits were then converted into Identification scale standard T scores based upon college norms ($N = 200$ males, 200 females).

3. *Appropriateness of the Parental Model*

The forced-choice parental descriptions which were used in deriving Identification scale scores were also used to judge masculinity-femininity of the parental model. These descriptions were obtained from 200 male and 200 female college undergraduates, and each trait was tallied for the number of times it was judged to be more characteristic of the mother or the father. It was found that for nine of the 15 traits, one parent or the other was predominantly (65 per cent to 73 per cent of the time) selected as being better characterized. Of these nine traits, four were perceived as more masculine (achievement, autonomy, dominance, and endurance) and five as more feminine (deference, affiliation, succorance, abasement, and nurturance). Masculinity-femininity of the parental model was determined by the correspondence of each *S*'s ascriptions to these nine sex-linked attributes, a plus score being credited for each time a parent was perceived as appropriately more masculine or more feminine than the parental partner. The range of scores was from zero to 9 for the mothers of female *S*s and

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[2] Achievement, deference, order, exhibition, autonomy, affiliation, intraception, succorance, dominance, abasement, nurturance, change, endurance, heterosexuality, and aggression.

1-9 for the fathers of male *S*s. *S*s providing parent-model scores in the middle of these ranges (scores of 4-5 for females, a score of 5 for males) were eliminated from the study to enhance the reliability of these judgments. Thus, an appropriate model for female *S*s was a mother whose model score was from 6-9, and an inappropriate maternal model was one whose score fell from zero to 3. For males, a score from 6-9 defined an appropriate paternal model, and from 1-4 an inappropriate father model.

4. *Measures of Aggression*

Three independent psychometric measures of aggression were obtained from each *S*: (*a*) the Aggression-scale score from the Need Scales, (*b*) the EPPS Aggression-scale score, and (*c*) the *Hypomania* scale (Ma) from the MMPI (8). The former two are published, rationally derived scales of aggression, whereas empirical evidence has accrued that Ma can be employed as a measure of aggression in males (16) and in females (1, 3, 4, 16). All three scales are scored in standard T units with a mean of 50 and an *SD* of 10.

5. *Subjects*

The 69 males and 63 females in this study were volunteers from a large undergraduate class in psychology at the University of Iowa. The mean age of the male *S*s was 20.2 years, and that of the female *S*s was 19.8 years.

6. *Procedure*

*S*s were given the approximately two-hour battery of tests in small groups with a fixed order of administration for each *S* as follows: (*a*) EPPS, (*b*) forced-choice parental descriptions, (*c*) Adjective Check List (7) from which the Need Scales are scored, and (*d*) social desirability ratings of the EPPS statements. The MMPI had been administered to a majority of the *S*s as entering freshmen at the university from 1-3 years prior to the present study, and the scores were available.

C. RESULTS

Since the Identification scale (IS) was new and had accrued no empirical evidence bearing upon its validity, a preliminary analysis was conducted to provide at least some evidence in this regard. The trait of dominance was selected because it is clearly sex-typed, and it was determined whether appropriately identified male *S*s in the study were more dominant than inappropriately identified males, and whether the reverse relationship held for females. An appropriately identified *S* was one who had an IS score > 50 and whose same-sexed parent provided an appropriate model, or was an *S* who had an IS score $\leqq 50$ and whose same-sexed parent provided an inappropriate model. An inappropriately identified *S* either had an IS score > 50 and an inappropriate same-sexed parental model, or an IS score $\leqq 50$ and an appropriate same-sexed parental model. The EPPS and Need Scale dominance scores for these differentially identified groups are given in Table 1. The analyses show that in three of the four identification × sex comparisons the differences in degree of dominance were in the predicted direction and highly significant. In the fourth comparison, the difference was in the expected direction and approached significance at $p < .10$. These preliminary results tends to support the validity of the Identification scale, at least as used jointly with a measure of adequacy of the parental model.

TABLE 1

COMPARISON OF EPPS AND NEED SCALE DOMINANCE SCORES FOR APPROPRIATELY AND INAPPROPRIATELY IDENTIFIED COLLEGE *S*s

Measure of dominance	Males					Females				
	Appropriate identification ($N = 33$)		Inappropriate identification ($N = 36$)			Appropriate identification ($N = 32$)		Inappropriate identification ($N = 31$)		
	Mean	*SD*	Mean	*SD*	t^a	Mean	*SD*	Mean	*SD*	t^a
EPPS	51.85	8.48	45.31	10.81	2.75**	47.50	10.46	51.84	12.10	1.51
Need scales	54.67	11.05	48.19	10.96	2.42**	45.88	9.10	52.74	7.65	3.21***

[a] One-tailed tests were used.
** Significant at the $p < .01$ level.
*** Significant at the $p < .001$ level.

The consistency-percentage scores for the appropriately and inappropriately identified male and female groups were compared next. The mean SV-SB consistency score for appropriately identified males ($N = 33$) was 72.56 ($SD = 14.27$), whereas inappropriately identified males ($N = 36$) provided a mean of 69.70 ($SD = 9.53$), the difference being nonsignificant ($t = .98$ for 67 *df*). The mean SV-SB consistency scores for female appropriately identified *S*s (68.63, $SD = 9.28$, $N = 32$) and female inappropriately identified *S*s (69.56, $SD = 9.66$, $N = 31$) also failed to differ significantly ($t = .39$ for 61 *df*). Thus, there was no support in either the male or female analysis for alternative hypotheses 1*a* or 1*b*.

The mean aggression scores for the appropriately and inappropriately identified *S*s and the results of the analyses relating appropriateness of identification and degree of aggression are presented in Table 2. The most

TABLE 2

COMPARISON OF EPPS, NEED SCALE, AND MMPI INDICES OF AGGRESSION FOR APPROPRIATELY AND INAPPROPRIATELY IDENTIFIED MALE AND FEMALE COLLEGE *Ss*

	Males					Females				
	Appropriate identification ($N = 33$)[a]		Inappropriate identification ($N = 36$)			Appropriate identification ($N = 32$)		Inappropriate identification ($N = 31$)		
Measure of aggression	Mean	*SD*	Mean	*SD*	t[b]	Mean	*SD*	Mean	*SD*	t
EPPS	55.55	9.60	52.58	8.60	1.34	51.75	8.43	55.19	8.82	1.57
Need scales	54.24	11.23	49.75	10.45	1.70	50.91	8.02	56.52	10.74	2.34*
Ma	58.25	13.47	56.42	7.41	.61	51.96	8.59	59.17	10.28	2.82**

[a] The *N*s in the four groups (across columns) for the Ma comparisons were 28, 26, 27, and 29.

[b] Two-tailed tests were used.

* Significant at the $p < .05$ level.

** Significant at the $p < .01$ level.

striking aspect of the data in this table is the apparent importance of sex in considering the relationship between identification and aggression. The interaction effects between aggression and appropriateness of identification as a function of sex are all significant: EPPS aggression, t for interaction = 2.03 for 128 *df*, $p < .05$; Need Scale aggression, t for interaction = 2.78 for 128 *df*, $p < .01$; Ma aggression, t for interaction = 2.34 for 106 *df*, $p < .05$. Thus hypothesis *2a* is supported by the results for females for whom inappropriate identification was associated with heightened aggression. However, hypothesis *2b* seems more tenable for the males, since appropriately and inappropriately identified males did not differ significantly on any of the indices of aggression.

To test hypothesis 3, the various appropriateness of identification by SV-SB consistency combinations were constituted by splitting the male and female consistency distributions near their respective medians (high-consistency males > 73.59 per cent, high-consistency females > 68.35 per cent) and assigning each *S* to one of four subgroups. The inappropriately identified, high-consistency (II-HC) and appropriately identified, low-consistency (AI-LC) subgroups would be expected to manifest more sex-atypical interpersonal behaviors than would the inappropriately identified, low-consistency (II-LC) and appropriately identified, high-consistency (AI-HC) subgroups, and these hypothetically paired subgroups were combined. The aggression data for the various subgroups and the combined pairs are found in Table 3. Comparisons of the combined subgroups support hypothesis 3 in the case of the male *S*s, but there is no support in the female comparisons.

TABLE 3

MEANS AND *SD*s ON VARIOUS AGGRESSION INDICES FOR MALE AND FEMALE IDENTIFICATION × CONSISTENCY SUBGROUPS AND COMPARISONS BETWEEN SUBGROUP COMBINATIONS

	Males							Females						
		Measure of aggression							Measure of aggression					
		EPPS		Need scales		Ma			EPPS		Need scales		Ma	
Subgroups[a]	*N*[b]	Mean	*SD*	Mean	*SD*	Mean	*SD*	*N*	Mean	*SD*	Mean	*SD*	Mean	*SD*
II-LC	22	51.36	5.73	46.00	8.24	55.31	5.15	13	55.46	9.34	58.85	10.16	58.00	10.87
II-HC	14	55.93	10.42	55.64	10.84	57.62	8.39	18	54.78	9.30	54.83	10.90	60.00	9.73
AI-LC	13	56.85	7.19	57.15	11.40	58.75	11.75	18	53.28	8.82	53.06	8.91	53.00	7.33
AI-HC	20	54.25	10.49	52.40	10.46	57.88	14.59	14	49.71	7.46	48.64	6.10	50.45	9.94
II-HC AI-LC } (1)	27	56.37	9.04	56.37	11.12	58.16	10.17	36	52.48	8.88	53.56	9.70	54.39	11.09
II-LC AI-HC } (2)	42	52.74	8.45	49.05	9.88	56.72	11.49	27	54.03	9.31	53.94	10.02	56.61	9.31
t^c (1 *vs.* 2)		1.65*		2.77**		.48			.67		.15		.80	

[a] II = inappropriate identification, AI = appropriate identification, LC = low consistency, HC = high consistency.

[b] The *N*s for the male groups were II-LC = 13, II-HC = 13, AI-LL = 12, AI-HC = 16; for the female groups these *N*s were 12, 17, 16, 11, respectively.

[c] One-tailed tests were used.

* Significant at the $p < .05$ level.

** Significant at the $p < .01$ level.

D. Discussion

The results of the present study provided some clarification of the relationships between the parental identification of the late adolescent, the consistency between his social values and his social behaviors and degree of aggression, but, as might be expected, many questions about this behavioral complex remained unanswered. For one, the failure to find a significant relationship between appropriateness of identification and SV-SB consistency leaves the question of the antecedents of differential consistency an open one. It is possible to reason *a posteriori* that these negative results could have resulted because both hypotheses are correct for discrete subsets of adolescents. The effect of having some appropriately identified *S*s show low SV-SB consistency because of rejection of parental values, and of having some inappropriately identified *S*s show low SV-SB consistency so that their behavior would conform to socially approved sex typing, would be to diminish differences in SV-SB consistency between differentially identified groups.

A negative relationship was found between appropriateness of identification and aggression for late adolescent girls, but these variables were unrelated for the male *S*s. Thus, Bandura and Walter's results which established that aggressive adolescent boys were less identified with their fathers than were their nonaggressive counterparts received indirect support for females only. The inappropriately identified males in the present study actually had lower aggression scores than appropriately identified males, though the differences were not significant. It is felt that these present results take on the greatest suggestive significance when considered in conjunction with the SV-SB consistency findings. When the males were grouped according to whether their manifest social behaviors would tend to conform to sexual stereotype (appropriate values—high SV-SB consistency, inappropriate values—low SV-SB consistency) or not to conform (appropriate values—low SV-SB consistency, inappropriate values—high SV-SB consistency), nonconformity was associated with heightened aggression. Since this conformity cuts across adequacy of identification, frustration as a function of social punishment for deviation from sexual stereotype seems a more parsimonious explanatory model for the male aggression in this study than does deficient internalization of controls. The girl *S*s in this study, in contrast to the males, failed to show any relationship between adequacy of identification, SV-SB consistency, and aggression, although they had shown an inverse relationship between appropriateness of identification and aggression. Thus, the control internalization model may be more relevant to explaining aggression in girls than frustration; however, since the presumably crucial variable, *degree* of identification, was not systematically investigated, this conclusion cannot be considered as having empirical roots in this study.

Bandura and Walters intentionally selected boys whose aggression was manifested in antisocial behavior. It was of interest to inquire whether the heightened aggression detected in the male college *S*s in the present investigation whose social behaviors tended to be sex-atypical might also be associated with antisociality. Scores on the Psychopathic Deviate scale (Pd) of the MMPI were available for many of the males, and it was found that the combined appropriately identified, low-consistency and inappropriately identified, high-consistency group ($N = 25$) did, in fact, have a reliably higher ($t = 2.35$, $p < .05$) mean Pd score ($\overline{X} = 62.28$, $SD = 7.65$) than did the combined appropriately identified, high-consistency and inappropriately identified, low-consistency group ($\overline{X} = 57.28$, $SD = 8.10$, $N = 29$). Inappropriately identified females who were characterized by higher aggression than appropriately identified females were not significantly higher ($t = 1.06$ for 54 df, $p > .20$) on the Pd scale ($\overline{X} = 55.97$, $SD = 6.81$, $N = 29$ *vs.* $X = 53.93$, $SD = 7.20$, $N = 27$, respectively). These results for the males are provocative since they suggest that one antecedent to psychopathology is the sequence of failure to meet social demands for sex-typical behavior, social punishment or withholding of social rewards, frustration, and aggression toward the source of frustration in the guise of antisociality. Almost a quarter century ago Knight (1938) made a similar observation regarding psychopathy manifested in alcoholism when he remarked:

> Innumerable personality shadings and accents are possible from a son's reaction to such parental management, but one regular result seems to be the fostering of excessive passive demands and expectations in the son—such passive, childish, feminine wishes being in marked conflict with masculine strivings inculcated by the father and by the cultural ideology absorbed from schooling and from contacts with other males.

More recently, Hathaway and Monachesi (9) have noted a "femininity of interest pattern" as a correlate of adolescent delinquency.

It should be stressed that the social frustration-aggression hypothesis is not offered as the basis for all heightened aggression in adolescent males, since poor internalization of controls or direct modeling after aggressive behavior in the father may more adequately account for aggression in any given case. It is also to be noted that the SV-SB variable as measured in this study is still open to alternative interpretations. For example, the low-consistency *S* might be considered as one who is generally less concerned with social demands to conform to accepted value systems, and thus less likely to experience frustration from social censure. However, arguing against such a contention is the previous finding (11) that low-consistency *S*s more frequently solicit professional help for problems in their interpersonal relationships than do high-consistency *S*s.

The basis for the marked differences in the patterns of relationships for female and male *S*s in this study remains a question to be answered by further research as well as the antecedents of SV-SB consistency. However, one possibility which exists is that sex-typicality of behavior for middle-class females holds considerably less priority with regard to social reinforcement than it does for males. This may be especially the case when a college female sample is used, since such a sample includes many who are rewarded for competing in areas (e.g., the basic sciences) and for goals (e.g., professional success) which have been traditionally male.

E. Summary

The present study was concerned with the relationships between psychometric measures of appropriateness (as to sex-typing) of identification, the consistency between social values and social behaviors, and aggression for college male and female *S*s. There was no relationship found between identification and consistency, leaving the question of antecedents to consistency still to be answered. Appropriately identified females were significantly less aggressive than girls who were not appropriately identified, whereas the opposite pattern was found for the males, but was not significant. Based on the hypothesis that sex-atypicality of personality characteristics would meet with social punishment and initiate a frustration-aggression sequence, subgroups were formed based on whether the appropriateness-of-identification, social-value, social-behavior combination would indicate sex-typical or sex-atypical social behavior. Male groups for whom sex-atypical behavior would be predicted were more aggressive than their sex-typical behavior counterparts, but no differences were obtained with females.

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BASIC DIMENSIONS OF LIGHT AS REINFORCEMENT: CHANGES IN PATTERNS, BRIGHTNESS AND MOVEMENT*[1]

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A. Introduction

The observation that light works as a reinforcer is by now a generally accepted fact. This is also true of a number of other so-called "nonhomeostatic" motivating stimuli.

This fact was established—as far as light is concerned—primarily through experiments performed by Girdner (1) and Marx, Henderson and Roberts (5). The latter authors proposed that it was a "stimulus change" which was responsible for the reinforcing properties of the light following an operant response. Levin and Forgays (3) showed the reinforcing effects of light to work also in a maze situation.

Three basic dimensions of light which are particularly suited for experimental investigations seem to be patterns, brightness, and movement occurring within the light pattern.

Brightness, up to a degree, enhances certain types of behavior and facilitates discrimination learning; beyond that point brightness begins to inhibit discrimination and exploratory behavior. This was shown in studies conducted by Jagoda and D'Amato (2). As is apparent from the literature, light has been used in many instances as a discriminative stimulus, but the differentially reinforcing effects of its own basic dimensions have been neglected in the psychological journals.

A notable exception to this are the studies of Stewart (7), and Stewart and Hurwitz (8). Findings obtained by these authors indicated that (*a*) response rate in a bar-pressing situation which was followed by the presentation of light seemed to be more important than intensity in subsequent ex-

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* Received in the Editorial Office on April 2, 1962. Copyright, 1964, by The Journal Press.

[1] This study was supported by a grant from the USPHS (M-5056), and was completed while the senior author was a participant in the Summer, 1961, Research Participation Program for Teachers at the Pennsylvania State University sponsored by the National Science Foundation (G15443 and G15758).

tinction trials, and (*b*) that the intensity of light increased directly as reinforcement only under an FR-schedule of reinforcement.

A recent study by McClearn (6) suggested that general illumination conditions in the environment of different strains of mice may act on mechanisms other than eye pigmentation, and may be involved as partial determinants of behavior mechanisms—such as fear, curiosity, or activity.

Lockard (4) allowed rats to expose themselves to light of a certain intensity with the aid of an operant self-regulating device. The duration of self-exposure was found to depend upon both the brightness of the light used for testing and the illumination in which rats were maintained before testing.

All the studies mentioned so far were concerned primarily with only one of the basic dimensions of light and its influence upon behavior.

The experiments presented here were attempts to investigate the reinforcing properties of patterns, degrees of brightness, and movement within patterns in an operant learning situation.

B. General Description of Apparatus

The apparatus consisted of a modified Skinner box, 10″ × 9″ × 9″, with sides of clear plastic, and ends of aluminum. The floor was constructed of a metal grid. Out of the front panel was cut an opening 2″ × 2″ in dimensions. This opening was centered in the front panel, and its lower side was .75″ above the grid floor. Immediately behind this opening was a small wooden box which housed the patterns, inserted between a layer of regular glass and milk glass, and a 7.5-watt light bulb. Attached to the outside of the front panel was a miniature electric-eye light source and a photocell in such a manner that a vertical light-beam appeared in the middle of the front-panel opening. To the photoelectric relay were wired a clock, a timer, and a counter. The light was wired through a variable resistor, permitting settings from zero to 13 footcandles (FC).

Thus, when the animal stuck its head through the opening in the front panel, it broke the light-beam, which in turn de-energized the relay, and presented the appropriate experimental condition to the animal as long as it had its head positioned inside the opening.

C. Experiment 1

1. *Patterns and Movement*

Thirty male adult albino rats from the Harlan Wistar strain, about 100 days old, were used as subjects.

All the animals were placed singly into the apparatus for a 10-minute period. During this time a response was reinforced by the presentation of a 3-cm^2 square pattern of light of 5-FC brightness. Immediately following this trial, all animals were returned to their home cages for a two-minute period. Then they were returned singly to the apparatus for another 10-minute period under one of the experimental conditions shown in Figure 1.

FIGURE 1
EXPERIMENTAL DESIGN FOR EXPERIMENT 1

1ST TRIAL	2ND TRIAL
□ 5 FC	△ 5 FC
□ 5 FC	△ 5 FC + Movement
□ 5 FC	□ 5 FC
□ 5 FC	□ 5 FC + Movement
□ 5 FC	○ FC
□ 5 FC	○ FC + Movement

The movement effect was obtained by inserting a specially prepared glass trough, inside of which were 10 common houseflies.

Thus, under the movement conditions, when an animal broke the light-beam it would be presented with one of the conditions shown in Figure 1, with vague outlines of the flies moving across the illuminated area of the patterns, the brightness of which was readjusted to 5 FC to absorb the slight dimming effect caused by the flies.

2. *Results*

The time scores obtained during the main testing trial were subjected to a factorial (3 × 2) analysis of variance. These data showed that the animals with the movement in the patterns looked significantly longer than those without it (F was 6.28 for 1 and 24 df; $p < .025$). The detailed effects of the experiment appear in Figure 2.

3. *Discussion and Conclusions*

From the results it appeared that an additional stimulus change, introduced by movement within the patterns of light, produced a clear reinforcing effect. From Figure 2 it is furthermore apparent that this effect was due solely to movement, since all other single or combined factors showed no significant increase of behavioral strength. It was clear from the data that when a change of stimulation from no movement to movement was accomplished by a stimultaneous change in patterns, the increase in behavioral strength (viewing time) which normally followed a change in movement alone, was offset apparently by the depressing effects of changes in patterns.

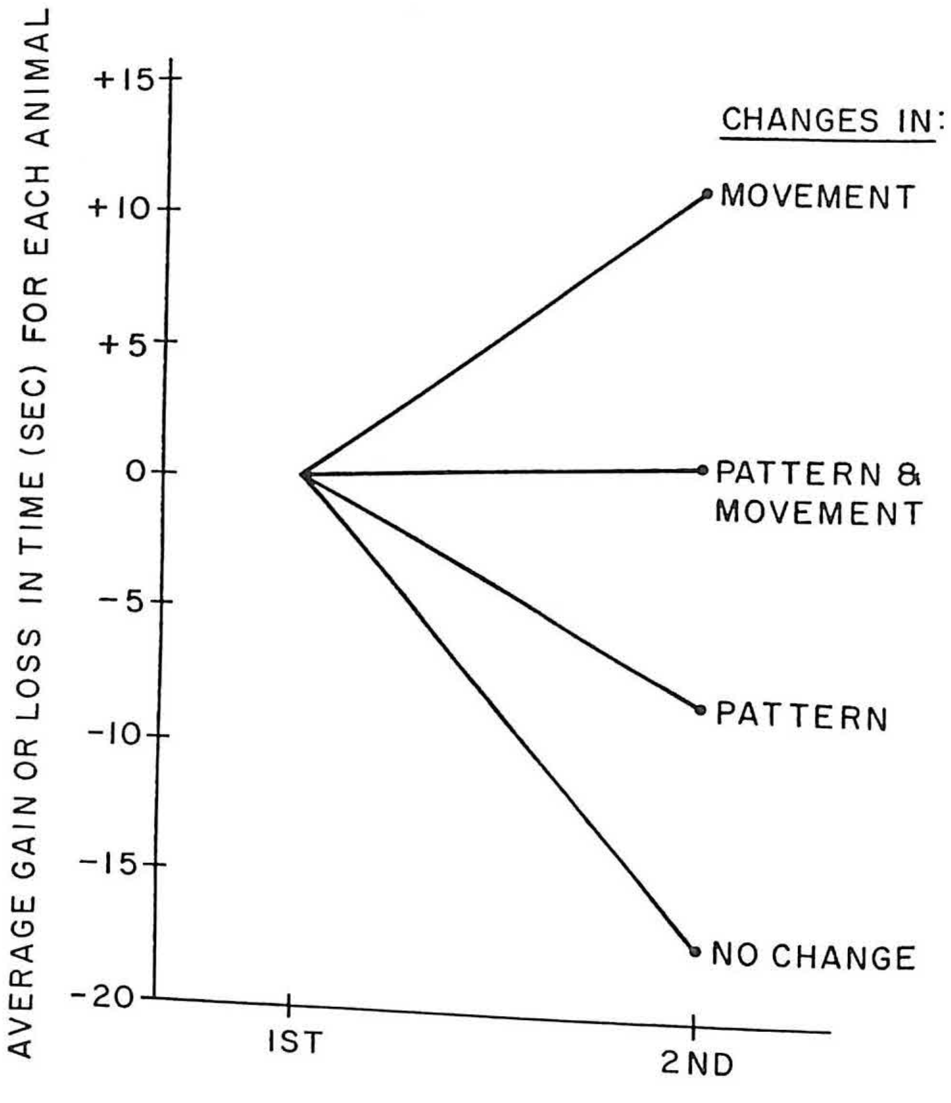

FIGURE 2
CHANGES IN PATTERNS AND MOVEMENT AS BEHAVIORAL DETERMINANTS
($N = 30$)

D. EXPERIMENT 2

1. *Brightness and Movement*

This investigation was concerned with the effects of changes in brightness and movement upon the behavior described in Experiment 1.

2. *Subjects and Procedure*

Thirty adult male albino rats from the Harlan Wistar strain were used as subjects in this study.

The procedure was identical with that described in Experiment 1, except that instead of the patterns (triangle, square, and circle), three degrees of brightness were employed. (See Figure 3.)

FIGURE 3
EXPERIMENTAL DESIGN FOR EXPERIMENT 2

1ST	TRIAL		2ND TRIAL
□	5 FC	□	1 FC
□	5 FC	□	1 FC + Movement
□	5 FC	□	5 FC
□	5 FC	□	5 FC + Movement
□	5 FC	□	10 FC
□	5 FC	□	10 FC + Movement

3. *Results*

Again the time scores were subjected to a factorial analysis of variance (3×2). The only significant difference which was apparent (F of 5.07 for 1 and 24 df; $p < .05$) favored movement over nonmovement. The detailed effects are shown in Figure 4.

4. *Discussion and Conclusions*

The results indicated again, as Experiment 1 showed, that movement alone had a significant reinforcement effect.

Again changes in brightness alone, or changes in brightness and movement, did not yield the expected results. From a detailed analysis of individual scores, it appeared that the animals receiving the lower brightness pattern with movement (square, 1 FC) seemed to have paid their attention to the movement within the pattern, whereas the other group (square, 10 FC) seemed to react to this pattern as if it were an aversive stimulus, despite the fact that it contained movement.

When we look at the data from Experiments 1 and 2, it now seems that whenever the change in the movement patterns was from the intermediate level of complexity (square, 5 FC) to the less complex level (either square and 1 FC, or triangle and 5 FC), the animals seemed to direct their attention more to the movement within the pattern; and whenever the change was to the more complex level, the animals seemed to pay more attention to the patterns or degrees of brightness.

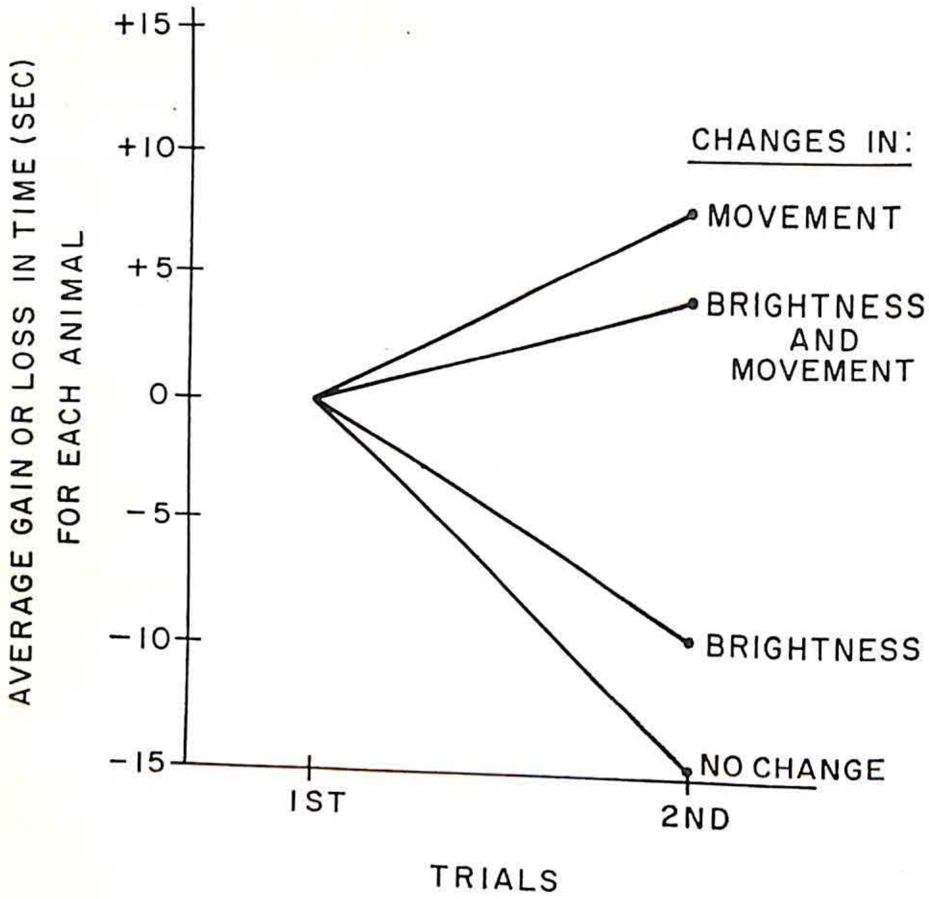

FIGURE 4
CHANGES IN BRIGHTNESS AND MOVEMENT AS BEHAVIORAL DETERMINANTS
($N = 30$)

E. SUMMARY

Two experiments were reported which were concerned with the effects of changes in patterns, degrees of brightness of light, and movement on operant behavior in rats.

A modified Skinner box, utilizing a miniature photoelectric device, was used to measure the total time during which the animals looked at light patterns.

Thirty rats each were used as subjects in the two experiments.

The following conclusions seem warranted:

1. A change in movement alone within the patterned light resulted in greatly increased behavioral strength; a change in either movement and pat-

terning or movement and brightness yielded a slight increase in behavioral strength; and changes in patterning alone, brightness alone, or no change yielded decreases from previously attained behavioral levels, all other things held constant.

2. Generally, it may be concluded that changes to a lower level of perceptual complexity (either in patterns or brightness) yielded increased behavioral strength, whereas the opposite was true of changes to higher levels of perceptual complexity of the patterns and of degrees of brightness used here.

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MANIFESTATIONS OF CEREBRAL DOMINANCE AND READING RETARDATION IN PRIMARY-GRADE CHILDREN*

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The phenomenon of the apparently intelligent child who cannot master the art of reading is one which has interested many persons both in education and in psychology. In every group of such children are found some who show such signs of cerebral-dominance anomaly as ambidexterity or lack of unilateral eye-hand preference. This coincidence has led to perennial investigations of a possible relationship between such characteristics and reading retardation since Morgan's original observation in 1896. Conflicting evidence as to the existence of such a relationship has accumulated.

A. PROBLEM

Much of the research on reading disability has been *post hoc* in that *S*s were selected from upper elementary grades after they had spent three or four years in unsuccessful efforts to learn reading (2, 11, 13). In many of these *S*s, no dominance anomaly was shown to be present, although the possibility was not considered that such a condition might have existed during the inception of reading instruction. Robinson (9), however, studied her *S*s intensively from kindergarten through the third grade, finding no difference in the reading ability of unilateral- and mixed-dominance groups. Since her *S*s were primarily children of professional parents, her findings are generalizable only to children of similarly high socioeconomic levels and superior intelligence.

Pragmatic evidence that a relationship between dominance anomaly and reading disability does exist is seen in the successful reading remediation of older children of mixed eye-hand preferences through training to unilateral eye-hand preferences (1, 6). Shepherd (11), after investigating the association of several signs of dominance anomaly with reading disability, concluded that only right-to-left drawing tendencies were significantly associated

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with reading difficulty. Johnson (4) has presented a comprehensive review of research in this area.[1]

B. Hypotheses Tested

Observation of poor readers who are ambidextrous or have mixed eye-hand preference led Berner and Berner (1) and Leavall (6) to conclude that it is a lack of unilateral eye-hand preference which accounts for reading difficulty. They hypothesize a confusion of tendencies which interferes with the learning of reading. It appears logical to posit on the basis of Orton's theory (8), however, that it is the lack of a controlling eye in binocular vision which is associated with the capacity of the hemispheric area to retain the proper orientation of the reversible symbol or figure. The objection may be raised that fibers from each eye extend to each hemisphere, so that the record of stimuli falling on each eye would be transmitted to each hemisphere. Two replies to this objection are possible: (*a*) that the crossed fibers may not be functional or may be operant alternately with the uncrossed fibers in certain subjects in early years, and (*b*) that, as Walls (12) has hypothesized, the visual mechanism is such that the stimulus of only one eye is attended to. In the present study, the following hypothesis was tested:

1. *The lack of a controlling eye in binocular vision is associated with retardation in reading in primary-grade children.*

Since studies of older children with reading disabilities failed to yield evidence of a lack of unilateral dominance traits in many cases, it appeared possible that the greatest influence of a lack of unilaterality occurred in the early years of reading instruction, although the cumulative effect of the consequent perceptual difficulties might be seen in later years. Thus, although a child might develop a decided unilaterality in visual perception in the second or third grade, his previous inability to learn the mechanics of reading would result in his reading retardation in these grades. The hypothesis tested here was:

2. *Greater differences in reading-achievement-score rank are observed in Ss with undecided versus decided control of binocular vision in early primary grades than in later grades.*

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[1] Recent negative evidence regarding this theory has been offered by Harry S. Beck, University of Virginia, 1960, in a Doctoral dissertation: "An Experimental Investigation of the Relationship of Hand-Eye Dominance and Reversals in Second-Grade Children."

Witty and Kopel (13) found no difference in dominance patterns in a group of good and poor readers in grades three to six. Although the lower limit of intelligence was specified in their groups, the upper limit was not, nor was matching of *S*s carried out. Robinson's mixed-dominant *S*s were all of superior intelligence (9). The outcome of these two studies suggests that mixed-dominant children of superior intelligence avoid the problems met by children having lower intelligence by using cues which are not perceived by the latter. This conclusion was tested here through the following hypothesis:

3. *Mixed-dominant Ss of median or above-median IQ (125 or over in the present group) do not differ significantly in reading achievement from unilaterally dominant Ss in the primary grades, while mixed-dominant Ss of below-median IQ (under 125) are significantly lower in reading achievement rank than unilaterally dominant Ss in these grades.*

Written and oral reversals of letters and words by children with a reading disability have been noted by several investigators (6, 8, 11). Various causes such as errors in copying and lack of attention to formal differences have been proposed. Orton attributed such reversals to a reversed mental image, or to the reaction in oral reading to the symbol perceived in reversed orientation. This formulation was indirectly tested in the present study through this hypothesis:

4. *Primary-grade children who reproduce the WISC Block Design A or the WISC Picture Arrangements in reversed orientation will show lower reading achievement than children who reproduce these figures correctly.*

Since these tasks are items on an intelligence test, the independence of *IQ* and dominance traits was also studied.

C. Method

*S*s were the 109 white, middle-class children in the primary grades of a public school.[2] All children were categorized as to handedness on seven performance criteria adapted from those of Robinson (9) and Johnston (5); they were classified as to monocular eye preference through the use of adaptations of the Parsons Manoptoscope used by Gates (3) and through the use of two tests described by Johnston (5). Binocular eye preference was determined by the use of an adaptation of the Scheidemann test (10).[3] Each *S* was then categorized "unilaterally dominant" or "mixed eye-hand dominant," depending on the pattern of preference for hand and eye (the latter in monocular vision). *S*s were further categorized as having a "controlling eye" in binocular vision if they had demonstrated a consistent preference for use of the same eye in the alignment task of the Scheidemann test, since in binocular vision a choice between the two eyes must be made if only one object is to be perceived.

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[2] The writer wishes to thank Wylie V. Harris, Superintendent, and the teachers at the Westwood View School, Kansas City, Kansas, for their helpful cooperation.

TABLE 1
SIGNIFICANCE OF READING-SCORE SUM OF RANKS;
VARIABLE—BINOCULAR-VISION CONTROL

	Binocular control present	Binocular control absent
N	45	64
Mean rank	52.4	56.83
Sum ranks	2358	3637
U	1323	
z	.72	
p	.2358	

Reading-achievement rank for *S*s in the first and the second grades was obtained from recent scores on the Gates Reading Test (Primary); scores on the Stanford Achievement Test (Primary) comprised the measure for *S*s in the third grade. The Average Reading Score was the measure used in all cases.

Nonparametric tests of significance were applied to ranked reading-achievement scores of mixed-dominant and unilaterally dominant *S*s to test the several hypotheses.

An *IQ* estimate for each *S* was obtained by deriving a composite score from separate group-testing results on the California Test of Mental Maturity and the Otis Quick-Scoring Test of Mental Ability.

D. RESULTS

Hypothesis 1 (The lack of a controlling eye in binocular vision is associated with retardation in reading in primary-grade children) was not supported by the outcome of a Mann-Whitney U Test applied to the ranked reading scores of *S*s in all primary grades. The resultant *z*-score of .72 was found to have a *p* of .2358, indicating that no significant difference existed between groups classified as having or lacking decided control in binocular vision.[4] (See Table 1.)

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[3] The adaptation of this test was suggested by Morton P. Goldman, Chairman, Department of Psychology, University of Kansas City.

Hypothesis 2 (Greater differences in reading-achievement-score rank are observed in *S*s with undecided versus decided control of binocular vision in early primary grades than in later grades) was supported in results of Mann-Whitney U Tests applied to the ranked reading scores of the two visual-control groups in two of the first three grades. A significant difference was found between reading-score ranks of *S*s with and without control of binocular vision in the second grade ($z = 2.62$, $p = .0045$), while no significant difference in reading-score rank was found between the third-grade *S*s with and without binocular-vision control. The outcome of a similar comparison of groups in the first grade does not support the hypothesis ($z = .39$, $p = .3483$). (See Table 2.)

TABLE 2

SIGNIFICANCE OF READING-SCORE SUM OF RANKS;
VARIABLE—BINOCULAR-VISION CONTROL
(Grades 1, 2, 3)

	Gr. 1 Control		Gr. 2 Control		Gr. 3 Control	
	Present	Absent	Present	Absent	Present	Absent
N	16	22	16	25	18	12
Mean rank	18.7	20.1	14.87	24.92	14.33	17.25
Sum ranks	299	422	238	623	258	207
U	163		102		87	
z	.39		2.61		.88	
p	.3483		.0045		.1894	

Hypothesis 3 (Mixed-dominant *S*s of superior intelligence do not rank lower in reading achievement than their peers, unlike mixed-dominant *S*s of below-median intelligence) was supported by the outcome of the two tests of this hypothesis. First, the application of the Mann-Whitney U Test to the ranked reading scores of *S*s with *IQ* equal to or above the group median yielded a z score of .08 for $p = .4681$, indicating no significant difference existed between reading ranks for the two dominance groups. Next, the Mann-Whitney U Test was applied to the ranked reading scores of *S*s with *IQ*s estimated at below the median who were classified as mixed

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[4] A full description of methodology, and a tabular summary of methodology and scoring criteria have been deposited as Document number 7746 with the ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D.C. A copy may be secured by citing the Document number and by remitting $1.25 for photoprints, or $1.25 for 35 mm microfilm. Advance payment is required. Make checks or money orders payable to: Chief, Photoduplication Service, Library of Congress.

TABLE 3
SIGNIFICANCE OF READING-SCORE SUM OF RANKS;
VARIABLE—EYE-HAND DOMINANCE IN
TWO *IQ*-RANGE GROUPS

	IQ less than 125		*IQ* 125 or above	
	Mixed E-H dominance	Unilateral E-H dominance	Mixed E-H dominance	Unilateral E-H dominance
N	30	42	12	25
Mean rank	31.05	40.25	18.34	19.18
Sum ranks	931.5	1696.5	220.5	482.5
U	466.5		142.5	
z	1.87		.08	
p	.0307		.4681	

eye-hand dominant or unilaterally eye-hand dominant. A z score of 1.87, with $p = .0307$ resulted, permitting the conclusion that the hypothesis was supported, both in this and the previous test. (See Table 3.)

TABLE 4
INDEPENDENCE OF CHARACTERISTICS OF *S*S;
VARIABLES—INTELLIGENCE AND EYE-HAND DOMINANCE

	Unilateral	Mixed	Total
N:IQ above or at median (125 or over)	37	19	56
N:IQ below median	33	20	53
Total	70	39	109
χ^2	.44		
df	1		
p	$< .70 > .50$		

TABLE 5
INDEPENDENCE OF *S*S' CHARACTERISTICS;
VARIABLES—INTELLIGENCE AND BINOCULAR CONTROL[a]

	Binocular control Present	Absent	Total
N:IQ above or at median (125)	34	18	52
N:IQ below median	21	27	48
χ^2	3.88		
df	1		
p	.05		

[a] Nine subjects whose binocular control could not be determined were excluded.

To determine whether the *IQ* scores were independent of eye-hand preference patterns, a chi-square test was performed with a resulting figure of .44, $p = < .70 > .50$. Thus, for the group of all *S*s, it can be concluded that eye-hand preference was not associated with *IQ* score to more than a chance degree. (See Table 4.)

However, a test similarly applied to assess the independence of *IQ* scores and binocular-control pattern yielded a χ^2 of 3.88, significant at the .05 level of probability and indicating that the two characteristics are not independent. This outcome suggests that it is the factor of lack of binocular control, resulting in perceptual uncertainties, which penalizes certain *S*s on tests of intelligence which present reversible figures to such *S*s. (See Table 5.)

TABLE 6
SIGNIFICANCE OF READING-SCORE SUM OF RANKS;
VARIABLE—DIRECTION OF WISC PICTURE SEQUENCES

			Direction	
	Left to right		Vertical and L-R or R-L	Right to left
N	95		7	7
Mean ranks	58.01		42.57	28
Sum ranks	5541		298	156
H		9.35		
df		2		
p		.01		

TABLE 7
SIGNIFICANCE OF READING-SCORE SUM OF RANKS;
VARIABLE—WISC BLOCK DESIGN 1 PLACEMENT*

	Correct placement		Reversed placement
N	90		8
Mean rank	63.51		34.88
Sum ranks	5716		279
U		243	
z		1.89	
p		.0294	

* Eleven subjects, whose response could not be scored, were excluded.

In the test involving arrangement of the WISC Picture Arrangement items "FIGHT" and "BURGLAR," responses were scored depending on whether the sequence was left-to-right, vertical, or right-to-left (Table 6). For all *S*s, a Kruskal-Wallis One-Way Analysis of Variance was applied to reading-score rank, resulting in an *H* of 9.35, significant at the .01 level, which supports Hypothesis 4 (Primary-grade children who reproduce the WISC Block Design A or the WISC Picture Arrangements in reversed orientation will show lower reading achievement than children who reproduce these figures correctly). In the second test of this hypothesis, a Mann-Whitney U Test was applied to the reading-score ranks of all *S*s who reproduced the design A correctly and those who did not; a *z* score of 1.89 was obtained, significant at the .0294 level of probability, which gave additional support to the hypothesis. (See Table 7.)

E. Discussion

The lack of difference in reading-score ranks of *S*s with and without visual-binocular control appears to support the contention of Berner and Berner (1) that it is the mixed eye-hand dominance condition which is the important factor in reading retardation. On the other hand, the finding in the present study that a significant difference in reading existing in second-grade *S*s grouped as to binocular-vision control, but that no such difference existed between comparable groups in the third grade, tends to support the position taken by Orton (8) and advanced in the present study. Thus, due to a differential rate of maturation of hemispheric function, mixed-dominant children would be penalized in learning to read due only to the lack of control in binocular vision. This lack would become less marked with progress through school, allowing *S*s to profit increasingly from proper reading instruction and thus narrowing the gap between them and their unilaterally dominant peers.

The failure of the study to find a significant difference between binocular-vision-control groups in the first grade suggests that the cross-sectional approach to the problem is inadequate; a longitudinal study of *S*s from the first through the third grades would offer a more accurate test of this hypothesis, provided *S*s of a wide range of intelligence were included. The outcome in the second and third grades in the present study can, however, be regarded as an indication of the reason for the failure of Witty and Kopel (13), and others, to find an association between dominance patterns and reading disability in upper elementary grades. If the lack of binocular control affects reading in early grades rather than the mixed eye-hand dominance condition, then it is conceivable that the former condition might be resolved through maturation while the latter is not. Thus the condition responsible for reading difficulty would not be present for study in later grades. However, unless the child was reexposed to basic instruction in reading, he would appear to have a reading disability in later grades.

The finding of a differential influence of the mixed-dominance condition in *S*s with above-median versus below-median *IQ* suggests that the superior group has the ability to employ tangential cues in identifying symbols which is not possessed by the middle- and lower-*IQ* groups. This finding underscores the need for a control group of lower-*IQ* *S*s in such studies as that of Robinson (9), who followed *S*s of superior *IQ* only through reading achievement in the first three grades.

A question is raised by the finding of the interdependence of *IQ* score and binocular-vision control; it must be determined whether a valid estimate of intelligence is obtained through the use of items sensitive to perceptual difficulties of a developmental nature. While the IQ score employed for the test of independence was an estimate of results of Otis and California tests, it should also be noted that *S*s arranging WISC designs incorrectly ranked significantly lower in reading achievement on both WISC items. In this connection, it may be inferred that, if Orton's theory is correct, even a prodigy such as Leonardo da Vinci might have scored lower on an *IQ* test as a result of missing such items.

The significantly lower reading-score ranks of *S*s who demonstrated a right-to-left or vertical directional tendency, as well as of *S*s who reversed the red and white colors of the WISC block design, are indirect evidence in support of Orton's hypothesis that the visual stimulus is in fact perceived by some *S*s as an isomeric engram. This finding extends the conclusions of Shepherd (11) into the primary-grade group. The scope of the present design did not include the identification of external signs of dominance in *S*s giving reversed perceptual responses; such a study would be of value in facilitating the classroom grouping of *S*s for special instruction in the reading-readiness period.

The finding of significant differences in three of the four hypotheses tested in the present investigation offers evidence for the tenability of Orton's theory, particularly as it affects binocular-vision control. The methodological difficulties encountered in ascertaining the nature of perception in primary-grade children, as well as arriving at a logical scoring procedure for their perceptual responses, offer a challenge to the ingenuity of researchers in this area.

F. SUMMARY

One hundred and nine primary-grade public-school children, primarily of upper-middle class, were classified as to hand and eye preference (the latter both in monocular and binocular vision); *IQ* and reading-achievement scores were obtained. The influence of the following variables on reading-score rank was studied: (*a*) presence or absence of a controlling eye in binocular vision; (*b*) differential occurrence of maturation affecting binocular-vision control in the first three grades; (*c*) *IQ* above group median in mixed-dominant *S*s and in unilateral *S*s, with reference to reading-achievement rank, as well as *IQ* below group median; (*d*) independence of *IQ* score and dominance characteristics; and (*e*) perceptual reversal tendencies.

In the total primary-grade group, the lack of a controlling eye in binocular vision was not found to be associated with lower reading rank; however, a significantly lower reading score was found for *S*s lacking binocular control in the second rather than in the third grade, supporting the hypothesis that maturation lessens the effect of this factor. The finding of no difference in the first-grade group indicated that no conclusion can be reached in the present study as to the tenability of the hypothesis in the presence of conflicting evidence.

A significant difference in reading achievement for all *S*s was obtained when those with mixed eye-hand preference in the *IQ* range under the group median of 125 were compared to those with unilateral preference in reading achievement rank in the same *IQ* range. No difference in reading rank was found between similar dominance groups in the above-median *IQ* range; the outcome of these two tests supported the hypothesis that the influence of dominance tendencies varies with *IQ* level.

*S*s giving a reversed response to the WISC Block Design A task scored significantly lower in reading achievement than others responding correctly. *S*s who placed the WISC Picture Arrangement items in other than a left-to-right sequence scored lower in reading rank than those who followed the left-to-right arrangement, supporting the hypothesis that a difference would exist.

Evidence for the tenability of the theory that cerebral dominance anomalies are associated with reading retardation was seen in the findings of this study. Relationship of these findings to studies by Witty and Kopel (13), Robinson (9) and Shepherd (11) was discussed.

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INFANTILE SHOCK TRAUMATIZATION AND SUBSEQUENT ADAPTABILITY TO STRESS *[1]

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A. PURPOSE

The role of early experience in later behavioral development has been of particular relevance to those concerned with the development of personality and psychopathology. Despite many empirical investigations during the past 20 years, very few generalizations can be made. King (11), in a review article criticizing the methodology of earlier studies, reached the conclusion that little had been adequately demonstrated beyond the broad generalization that *some* early experiences affect *some* later behaviors in *some* ways. King recommended that future research be more parametric in nature (i.e., devoted to investigating the variables associated with the effects of early experience).

The variables investigated in this study were age at time of experience, intensity of experience, and type of adult behavior influenced by early experience. The investigation was specifically concerned with the effects of shock traumatization at different points in life upon adaptability to stress and emotionality measured in adulthood.

Findings relative to age at time of experience are inconclusive. Studies which have included groups traumatized in infancy have discovered significant behavioral effects in comparison to nontraumatized animals (8, 9, 21). However, studies which have included groups traumatized both in infancy and in adulthood have generally failed to discover significant differences between these groups (1, 2, 10).

With regard to the variable of intensity of experience, Levine (13) and Denenberg (6) have demonstrated that the initial effect of infantile traumatization is to increase the ability to adapt to stress toward an optimal level,

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but that increasing intensity by further traumatization results in an organism with markedly reduced capacity to respond to environmental stress in adulthood.

Effects of early traumatization on later behavior have most frequently been demonstrated on stressful tests. If a modification in adaptability to stress was being produced by early traumatization, then—as Levine suggested—future experiments designed to include nonstressful tests would not expect to obtain significant differences between traumatized and nontraumatized animals on these tests.

Two major predictions were advanced in this study. (*a*) Animals exposed to shock traumatization following weaning will make significantly more errors on stressful performance tests and will show greater emotionality than will animals that have been shocked in infancy. (*b*) Animals which have not been shocked at all will make significantly more errors on stressful performance tests administered in adulthood and will show greater emotionality than animals which have received shock. Animals which have received high shock will make significantly more errors than animals which have received low shock. None of these differences, however, will be apparent on a nonstressful test.

B. METHOD

1. *Subjects and Apparatus*

Ninety naive albino rats of the Wistar strain bred from available stock at the Perry Point Veterans Administration Animal Laboratory were used. The animals were from 31 litters.

A clear plastic box, 8.5 × 6 × 8.5 inches, was used to shock all experimental animals. The grid floor consisted of 30 wires spaced 1/4 inch apart. The shock box employed a new principle to deliver an inescapable shock (5). Briefly, grid wires were interconnected through small neon lights arranged in series. When *S* touched across several wires, the flow of current was diverted from the neons through the body of the animal.

Of the three performance tests, two were defined as stressful in nature and one as nonstressful. The stressful tests involved an avoidance-conditioning procedure and a water-escape maze; the nonstressful test, a food-approach maze.

An L-shaped shuttle maze was used for avoidance conditioning. The box measured 18 × 11.5 × 8 inches, and was constructed of galvanized tin. The procedure employed in the shock box was also used in the shuttle box to assure an unavoidable constant-current shock. The box was partitioned by a sheet-metal insert into two compartments. In the partition was an opening covered by a 5 × 3 inch aluminum door mounted on a long movable rod. When the rod was swung aside, the door opened, permitting free access between the compartments. Only the grid of the right-hand compartment was electrified so that the animal moved in one direction. A 6-volt buzzer, placed beside the apparatus, constituted the conditioned stimulus.

The water maze utilized was that developed by Rosvold and Mirsky (17). It was 30 inches square and 12 inches deep. Each day the maze was filled to a depth of 9.5 inches with tap water regulated to an approximate temperature of 89 degrees Fahrenheit.

The water maze was converted to a food maze by inserting an unpainted plywood false bottom into the tank, reducing the depth to 4 inches. Error zones were demarcated by metal rods laid on the screen covering the maze.

Finally, an open-field test was used to measure emotionality in adulthood. For this test, the false bottom was inserted into the tank described above, and the hardware-cloth screen was removed. The floor was marked off into three concentric squares. Each of these squares was subdivided into smaller 6-inch squares.

2. *Procedure*

a. Infant treatment group. Half of the 90 *S*s were assigned to the infant treatment group; the remaining half to the adult treatment group. Following a split-litter technique, on the day after birth the litters were randomly and evenly divided into three groups disregarding sex for the time being: pups administered a low shock in infancy (LS Group), pups administered a high shock in infancy (HS Group), and control pups (NS Group). The entire litter, however, remained with the original mother until weaning. The LS and HS Groups were removed each day for the first 20 days of life from the nest, transported in a metal container to the experimental room, and submitted, one at a time, to a continuous, inescapable shock for three minutes. The shock levels were .2 ma for the LS Group and .5 ma for the HS Group. Handling of the animals was kept to a minimum. The animals were simply taken from their nests, placed into the shock box, and returned to the nest. The NS Group was left in the nest with the mother until weaning. This group was neither handled nor placed on the grid without being shocked as the usual procedure would dictate, inasmuch as handling *per se* can act as a stressful agent (3, 14, 20). At the end of 21 days all infant groups were weaned, the females discarded from the treatment groups, and the males housed four or five to a cage. As random selection at birth would allow, one male animal from each litter was assigned to each treatment group. Following weaning, the infant group was not further disturbed until 98 days of age except for being weighed and differentially identified by means of a color code applied to the tails at 50 days. *S*s were maintained during this period on *ad libitum* food and water. The food provided was lab-chow pellets, supplemented once weekly with lettuce.

b. Adult treatment group. The 45 animals comprising the adult treatment group were also randomly assigned on a split-litter basis to three groups: an LS Group, an HS Group, and an NS Group. The shocking procedure and shock levels were identical to those of the infant treatment group. Exposure to shock began at 50 days of age and continued for 20 consecutive days. The NS Group was completely ignored for the corresponding 20 days. At 70 days, the adult group was weighed and placed four or five to a cage, not to be further disturbed until 98 days.

Testing began for all animals at 98 days. Each animal was first exposed to the open-field test for a five-minute period. To determine the reliability of the test, *S*s were run on two successive days. The animal was placed in the center of the apparatus, and *E* counted the number of squares traversed. Movement into an adjacent square was recorded when all four paws crossed the boundary line. The scoring system was patterned after one used by Ader (1). The squares in the outer area closest to the walls counted one point, the second rim counted two, and the center square counted three. An *S*'s score for each day was determined by adding the scores assigned to the varying squares traversed. The number of defecations during each testing period was also recorded.

Following the open-field tests, all *S*s were randomly assigned to one of the three tests. King (11) raised the question of the effect of prior tests on subsequent ones in any multiple-testing procedure, and McMichael (15) noted a significant order effect when making use of several tests. Consequently, any *S* was run on but one of the tests, making the results independent of possible order effects.

*S*s tested on the food-approach maze were placed on a 23-hour deprivation schedule immediately after completing the open-field tests. Water was always available to these animals in the home cages, but food was not. This deprivation schedule left *S*s at 80 per cent of body weight at the completion of the experiment.

For the first two days of adaptation, the barriers were removed from the food-approach maze, and the hungry animals, usually in groups of two to four, were allowed 30 minutes of free exploration. *S*s received a food reward as often as they entered the goal box. On the next day, the barriers were arranged in the form of the first of a series of six training problems. Nine trials were given daily on each problem. Time to reach the goal was recorded. Training was continued, starting again with the first problem if necessary, until each animal reached the goal within 60 seconds for nine trials on two successive problems. Animals that reached criterion early continued the series of problems for five trials a day until all *S*s had reached the criterion. Rabinovitch and Rosvold (16) have data to indicate that these extra runs beyond criterion do not significantly influence subsequent scores. Having reached criterion, the rats were run for eight trials per day on each of 12 test problems. The number of blind alleys entered on each trial was recorded.

The procedure for the water maze was unchanged from that in the food-approach maze. The criterion, however, was the completion of nine trials within 75 seconds on two successive training problems as used by Rosvold and Mirsky (17).

*S*s randomly assigned to avoidance conditioning were given five minutes of free exploration on the first day. At the end of this period, the buzzer was sounded for three seconds at 30-second intervals. If the animal continued to respond to the buzzer with fright or avoidance after three presentations, further presentations were given until *S* no longer reacted. Avoidance conditioning began on the next day. The animal was placed in the shock compartment, the buzzer sounded, and the door simultaneously opened. After three seconds, the grid was charged with .5 ma of current. Whether or not *S* responded correctly, the shock was terminated at the end of five seconds, and this represented a trial. Ten trials were given daily. Adjustments were made in the amount of current delivered to the grid so that all *S*s were receiving the same shock level in proportion to body weight. When an animal reached the "safe" compartment, the door was closed, and *S* was permitted to remain for 20 seconds before being returned to the other compartment. An error was counted each time *S* failed to avoid the shock. The criterion for learning was the errorless completion of nine of 10 trials over two successive days.

During extinction, the procedure was identical to that in acquisition, except that the animal was no longer shocked. Extinction trials were continued until *S* failed to respond during the three seconds the buzzer sounded on three successive trials.

C. RESULTS

The results are presented primarily with reference to Tables 1 and 2. Note that only *significant* results of the seven analyses of variance are presented in

Table 1. In each of the separate analyses, two main effects—intensity of shock and age at time of experience—were obtained as well as the interaction term between these effects. Data submitted to analysis included total errors in food-approach maze, water-escape maze and avoidance conditioning, trials to criterion of extinction in avoidance conditioning, motility and defecation scores of open-field test, and terminal weights.

TABLE 1
SIGNIFICANT RESULTS[a] OF ANALYSES OF VARIANCE OF VARIOUS MEASURES

Variable	*df*	*F*	*p*
Water-escape maze			
Age	1, 29	5.87	$< .01$
Avoidance conditioning			
Intensity	2, 29	6.29	$< .01$
Open-field test: motility			
Intensity	2, 89	11.32	$< .001$
Age	1, 89	9.97	$< .01$
Intensity × Age	2, 89	4.28	$< .05$
Open-field test: defecations			
Intensity	2, 89	24.35	$< .001$
Age	1, 89	10.91	$< .01$
Intensity × Age	2, 89	7.44	$< .01$

[a] Of 14 possible main effects, six were significant at the .05 level or less.

1. *Food-Approach Maze*

No significant differences were obtained between infants and adults nor among shock groups in number of errors made on the nonstressful performance test.

2. *Water-Escape Maze*

A significant age effect on the total number of errors made on the 12 test problems is indicated in Table 1. Reference to Table 2 indicates the direction of this effect. *S*s traumatized in infancy made significantly fewer errors ($p < .01$) than the group traumatized in adulthood on this stressful test, irrespective of level of shock traumatization or whether they were traumatized at all.

3. *Avoidance Conditioning*

A significant intensity effect was obtained on the total number of errors made in acquisition as indicated in Table 1. The difference between the mean of the NS Group and the mean of each of the shocked groups was statistically significant by a *t* test ($p < .05$) whereas the difference between the means of the two shocked groups was not significant. Significant differences attributable to either main effect were not obtained in trials to extinction.

4. *Emotionality*

Reliability indices were computed by a Pearson product-moment correlation between the motility scores on days 1 and 2 and between the number of defecations on each of the two days. The correlation obtained for the motility scores was .94, and for the defecation scores, .73.

In the analysis of the total number of squares traversed on both days, an F significant beyond the .01 level was obtained for the age effect and the intensity effect, as well as an interaction effect significant beyond the .05 level. The NS Group was less emotional than the LS Group ($t = 1.48$, $p < .10$) and the HS Group ($t = 3.96$, $p < .001$), and the infant group was less emotional than the adult group ($t = 2.78$, $p < .005$). The significant interaction was derived from the difference between infant shocked and adult shocked groups since both nonshocked groups had approximately equivalent mean motility scores. Further support for the age and intensity effect on emotionality was found in the analysis of the defecation scores. Both main effects and the interaction term were significant beyond the .01 level. The direction of the differences was identical to that described above.

5. *Terminal Weight*

No significant differences were obtained in the analysis of variance of the terminal weights. However, animals shocked in infancy tended to be heavier, though not significantly so, than animals exposed to the same experience at a later point in life.

D. DISCUSSION

The results of this experiment indicate that the age of experiencing traumatization is important to later adult emotional behavior. This finding is based on the significant interaction terms found for both motility and defecation scores. The general effect of shock traumatization was to increase S's emotionality in later adult behavior. However, the increase in emotionality was greater when the traumatization was applied in adulthood than when it was applied in infancy.

Differential effects attributable to early experience were demonstrated with regard to emotionality, but were not on the performance tests. A significant age effect was obtained on the water-escape maze, but these differences cut across the entire group regardless of the type of treatment. With the exception of the age effect on the water maze, this experiment did not demonstrate any differential early experience effect on the performance tests used. This

TABLE 2

MEANS AND STANDARD DEVIATIONS FOR EACH TREATMENT GROUP ON ALL MEASURES

Variable	Total *N*	NS (*N* = 10) Mean	NS (*N* = 10) *SD*	LS (*N* = 10) Mean	LS (*N* = 10) *SD*	HS (*N* = 10) Mean	HS (*N* = 10) *SD*	Total *N*	I (*N* = 15) Mean	I (*N* = 15) *SD*	A (*N* = 15) Mean	A (*N* = 15) *SD*
Avoidance conditioning Acquisition (errors)	30	6.10	1.51	9.70	3.35	10.90	3.65	30	8.20	3.65	9.60	3.44
Avoidance conditioning Extinction (trials to criterion)	30	69.10	38.37	60.80	27.77	72.60	44.89	30	62.13	37.43	72.86	37.81
Water maze (errors)	30	198.10	48.47	211.20	40.05	222.30	48.39	30	190.80	30.17	230.26	51.99
Food maze (errors)	30	173.20	30.37	190.90	39.85	189.00	42.76	30	177.26	35.64	191.46	39.84
			(N = 30)		(N = 30)		(N = 30)			(N = 45)		(N = 45)
Open-field test Motility	90	85.81	23.43	77.80	18.27	57.83	30.80	90	81.52	23.52	66.11	28.73
Open-field test Defecation (both days)	90	1.43	1.06	3.23	2.06	3.43	1.69	90	.80	.72	4.60	1.88
Terminal body weight (grams)	90	309.90	41.05	329.50	61.71	310.43	50.82	90	321.22	44.36	312.00	59.50

finding is in agreement with previous research which included an adult treatment group. These results would indicate the need for re-examination of past studies which found an early experience effect.

One conceivable explanation for the age effect in this study was the differential time lapse between time of traumatization and time of testing in the adult and infant treatment groups. The lapse was 80 days for the infant treatment group and 30 days for the adult treatment group. It was not possible to remove statistically the confounding effect which was inherent in the design. It will remain for future research to determine the influence of length of the neutral period in studies of this type.

The second parameter explored in this experiment was intensity of experience. Under investigation was the notion based upon the results of Levine (13) and Denenberg (6) that mild shock would be most facilitative to adaptability to stress. Denenberg proposed a curvilinear relationship between intensity of experience and adaptability to later stress. He predicted that animals exposed to a moderate amount of stress would be superior in adaptability to later stress than animals exposed to either an excessive amount of noxious stimulation or no traumatization. The findings of this experiment do not support this position. Instead of a curvilinear function, a linear relationship was obtained, with the NS Group being superior in their adaptability to later stress to either shocked group, and the HS Group being poorest in adaptability to later stress.

On the other hand, the results of the study support a formulation advanced by Bovard (4) concerning the effects of early experience on resistance to stress. On the assumption that the organism has at its disposal a limited reservoir of resistance to stress, Bovard maintained that early stress decreased the ability to resist later stress. Early stress could be thought of as sapping or chipping away at the organism's resources and bodily defenses, thereby lowering the capacity to resist later stress. One would predict from this position that animals that have not been shocked in infancy will be superior learners under stressful conditions than animals that have been shocked in infancy. These are essentially the results of this study.

Significant differences on the emotionality measures were also contrary to the findings of Denenberg. In very recent work, Denenberg (7) reported that nonshocked animals were more emotional than shocked ones. The present results are more in accord with the findings of Kurtz and Pearl (12) and those of Scott (18). The former authors demonstrated that experiences of intense fear tended to make animals more fearful in future fear-producing situations. The latter author found that a shocked group of rats was least active in a locomotor situation. In the present experiment, both shocked groups were more emotional than a nonshocked group on an open-field test.

The third parameter investigated was related to the type of behavior influenced in adulthood. The results of this experiment indicate that the effect of exposure to traumatic shock on behavior in stressful tests depends upon the similarity of the test to the original traumatic situation. Previous exposure to shock had no apparent effect on a future stressful test not involving shock nor on a nonstressful test, but only on a stressful test which included shock. This is the same kind of specific relationship noted in the studies of Baron, Brookshire and Littman (2) and Stanley and Monkman (19). It would appear that exposure to a specific traumatizing agent over a prolonged period of time does not necessarily produce a generalized impairment in ability to function under all types of stress. The effect of the traumatization appears to dissipate with the decrease in similarity between the test administered and the original traumatic situation.

E. Summary

The purpose of the present experiment was to explore three parameters assumed to be important in early experience research—the intensity of experience, the age of experience, and the type of behavior affected by the experience.

Three treatment groups, each consisting of 30 male albino rats, were established. One group was administered a low shock of .2 ma for 20 days; the second group received a high shock of .5 ma for the same length of time; the third group served as a nonshocked control. For one-half of the animals, the treatments were applied prior to weaning, while to the other half the identical treatment was applied later in life. When the rats reached 100 days of age, they were tested on a variety of performance tests.

The effects of the early traumatization were assessed by the following measures: avoidance conditioning, water-escape maze, food-approach maze, open-field test, and body weight.

The major findings indicate:

1. Traumatization applied in infancy produced significantly differential results from traumatization in adulthood only on measures of emotionality.

2. Contrary to prediction, whenever differences existed, nonshocked animals proved to be superior in learning ability to, and less emotional than, the shocked groups.

3. Previous experience with shock produced decremental performance on

a stressful test involving the repetition of shock, but not on a stressful test not involving shock nor on a nonstressful test.

The results were discussed in terms of their discrepancy and/or correspondence with previous research and theoretical formulations, and as indicating the need for more research of an exploratory nature within the area.

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BOOKS

Now that there is a special APA journal completely devoted to the publication of book reviews, it is no longer necessary that other journals emphasize such publication. It has always been our conviction that book reviews are a secondary order of publication unless they carry information that is as equally important as the book. However, the publication of book titles is a very important service, and we shall continue to render that service.

In any given issue of this journal, we may continue to publish one or more book reviews, but we do not consider such publication a major function of this journal. In line with this policy, we can no longer pay for such manuscripts.

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PREMATURE AGING AS A FUNCTION OF LONG-TERM ENVIRONMENTAL STRESS*[1]

Department of Psychology, Boston College

WILLIAM P. PARÉ[2]

A. OBSERVATION

The observation that neonatal and senescent organisms do not readily adapt to stress led Selye and Priorieschi (17) to emphasize the resemblance between the aging process and Selye's triphasic general-adaptation-syndrome. On the assumption that organisms are born with a fixed quantity of adaptive energy, Selye and Prioreschi theorized that the onset of senescence is a function of the rate of adaptive-energy expenditure. There are at least two implications to this theory. One implication is that the aging process is accelerated by repeated exposures to stressful stimuli. The second implication is that older organisms cannot adapt to stress as readily as can young adult organisms. This "wear-and-tear" theory of aging has been mentioned by Bortz (4) and by Platner (14).

The hypothesis that old age is characterized by decreased ability to adapt to stress has received some experimental verification (7, 21). Little evidence, however, exists to support the contention that chronic stress can initiate premature physiological aging. Some investigators have studied the effects of strictly physiological stressors, such as radiation (6) and high altitude (20), and have concluded that these factors shorten life-span.

The purpose of this study was to investigate the relationship between long-term exposure to psychological stress and the aging process in male rats. Indices of physiological aging were basal metabolic rate (BMR) and size of the prostate gland. A decrease in BMR with old age has been demonstrated repeatedly (3, 15, 18). Prostatic hypertrophy is also characteristic of the senescent human male. Moore's survey (12) led him to state that approxi-

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[2] The author would like to thank Joseph Cullen and Andrea Beall who assisted in collecting the data, and Elizabeth O'Connell who standardized the BMR apparatus and procedure.

mately 78 per cent of all 80-year-old men demonstrate prostatic hypertrophy In contrast, it is unknown at the age of 20 and rare at the age of 40. Several investigators (5, 9, 11) concur with Moore's observation.

For this study, psychological stress was defined in terms of tone-shock presentations. Previous work (13) demonstrates that a CS tone significantly enhances a rat's response to stress when stress is indicated by adrenal size, stomach ulceration, and body-weight loss. The hypothesis to be tested was that rats subjected to a chronic shock-stress condition exhibit a reduced BMR and a higher prostate-weight body-weight ratio than rats not subjected to such stress. To determine the relative stressfulness of different experimental conditions, the author obtained blood differentials as well as estimates of adrenal size.

B. METHOD

1. *Subjects*

The study utilized 48 male Sprague-Dawley albino rats approximately 105 days of age at the beginning of the experiment.

2. *Apparatus*

Experimental stress chambers consisted of boxes seven inches wide, eight inches deep, and seven inches high. Except for the front wall, which consisted of plastic and served as a door, all walls were made of wood. A two-inch hole was located in the ceiling above which a small speaker was attached. The floor consisted of brass rods 3/16 of an inch in diameter and spaced one-half inch apart. Each chamber was placed inside a ventilated picnic cooler. When the cooler doors were in place, chambers were isolated from one another with respect to sound. The author's hope was to provide a constant physical environment. A Scientific Prototype Shock-source and Scrambler (Model No. SS13) was used to charge the chamber grids. Tone was supplied by an Eico audiogenerator (Model 377). Presentation of stimulus events was controlled by a Gerbrand's tape programmer.

The apparatus for determining BMRs was a modification of Benedict's apparatus (2). It consisted of an animal cage of hardware cloth, nine inches by four inches by four inches, situated inside an air-tight plastic chamber. Air within the BMR chamber was circulated through a canister that contained soda lime. The soda lime removed carbon dioxide from the system. The chamber was connected to a spirometer that had a capacity of one liter. The rat's consumption of oxygen caused a loss of chamber volume. Loss of chamber volume caused a drop of the spirometer bell. Volume changes were monitored by an Esterline-Angus milliammeter that recorded rate of oxygen consumption as measured by the spirometer.

3. *Procedure*

Prior to the experimental period, blood smears were obtained from the tail blood of each rat. Base measures for BMR, blood eosinophils, and lymphocyte were also obtained. The number of eosinophils and lymphocytes per 100 leukocyte cells was ascertained. Two blood differentials were obtained. BMR was obtained after the rat was placed in a restraining cage and after the restraining cage was placed within the plastic chamber. After the chamber was inspected for air leaks, the test was made.

At the beginning and the end of a test period, chamber temperature and barometric pressure were recorded. The amount of oxygen consumed during the 30-minute test period was measured, and the calorie output per square centimeter of body surface per day was calculated. To make this calculation, it was assumed that one liter of oxygen was equivalent to 4.8 calories. All measurements were corrected for standard temperature and pressure. Body surface area was calculated according to the formula: body surface area (in square centimeters) $= .0011 \times$ body weight (in grams)$^{.63}$. Three BMRs were obtained for each rat prior to the experimental period. Four days intervened between each determination. The average of the three measures served as the BMR for each rat.

Each of the 36 rats was placed in his individual chamber for an habituation period of seven days. On the eighth day, the stress schedule was initiated. The stress schedule consisted of a four-second, 1,700-cps tone followed immediately by a one-second shock of 2.5 milliamperes. Tone-shock pairs were presented randomly with an average interval of three minutes between successive pairs. Twelve rats, designated tone-shock animals (TS), received both shock and tone. Twelve rats, designated "no-tone, shock" animals (NTS), received shock only. Twelve rats, designated "no-tone, no-shock" animals (NTNS), received neither tone nor shock and served as chamber control animals. Twelve rats remained in their individual home cages in the animal room and served as home cage controls (HC). The stress period lasted 20 hours per day for each of 24 days. Each rat had continuous access to food and water. On the 19th and 23rd day of the stress period, BMR was determined for each rat. On the first stress day, and every fourth day thereafter, blood differentials were procured for each rat. Upon termination of the stress period, all rats were sacrificed. Adrenal and prostate glands (*a*) were removed, (*b*) were quick-frozen with dry ice, and (*c*) were weighed on a Mettler analytical balance. The prostate glands were placed in an oven at 57°C for 42 hours. A dry weight was then obtained.

C. Results

Analysis of the adrenal-weight, body-weight ratios reveals significant differences among the four experimental groups ($F = 5.02$; $df = 3, 44$; $p < .01$). Comparison of group means by Duncan's multiple-range test indicates that tone-shocked rats differ significantly ($p < .01$) from rats in the other three groups. The data are presented in Table 1.

TABLE 1
Means and Standard Deviations of Adrenal-Weight, Body-Weight Ratios

	Experimental treatment			
Parameter	Home cage control	No tone-No shock	No tone-Shock	Tone-Shock
Mean	.1141	.1175	.1231	.1404
Standard deviation	.0127	.0195	.0118	.0183

An analysis of variance for the lymphocyte and eosinophil data indicates that the experimental treatment has effects significant beyond the .01 level (lymphocyte: $F = 11.48$; $df = 3, 44$; eosinophil: $F = 9.73$; $df = 3, 44$). Comparison of group-treatment means indicates that both lymphocyte and eosinophil counts for NTS rats and TS rats are significantly less than counts for NTNS rats and for HC rats. See Figure 1.

By dividing each rat's initial BMR into the mean of the last two BMRs

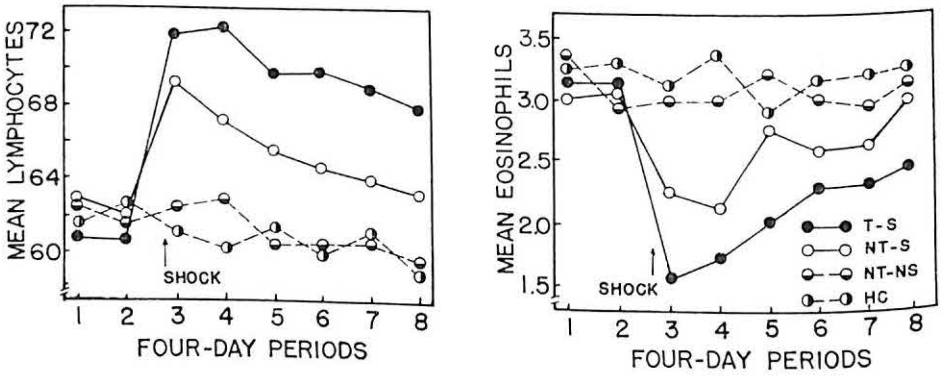

FIGURE 1
Mean Lymphocyte and Eosinophil Responses

determined under stress, a BMR percentage-change score was obtained. Differences among mean percentage changes were not significant ($F = 2.27$; $df = 3, 44$; $p > .05$).

Analysis of prostate (wet weight), body-weight ratios indicates that prostate glands of TS and NTS rats are larger than those of other rats. The differences are significant beyond the .01 level. Analysis of dry weights produces similar results ($F = 5.62$). Wet and dry weights for prostate-body ratios are presented in Table 2.

TABLE 2
MEAN RATIOS OF WET AND OF DRY PROSTATE WEIGHT (IN MILLIGRAMS) TO BODY WEIGHT (IN GRAMS)

	Experimental treatment			
Weight	Home cage control	No tone-No shock	No tone-Shock	Tone-Shock
Wet				
Mean	2.07	2.29	2.94	3.17
Standard deviation	0.51	0.77	0.72	0.92
Dry				
Mean	0.36	0.36	0.39	0.40
Standard deviation	0.09	0.10	0.10	0.11

D. DISCUSSION

The eosinopenia manifested by TS and NTS rats supports the results obtained by Anthony and Ackerman (1) and by Speirs and Meyer (19). The elevated lymphocyte response to stress agrees with the findings of Selye (16) and with those of Farris (8). The significant adrenal hypertrophy manifested by TS rats supports previous results secured by the author (13) and demonstrates that the presence of a warning tone increases the stressfulness of the shock-stress situation. On the basis of the blood data and the adrenal gland data, we conclude that the TS condition is more stressful than any condition without tone.

The negative BMR results are not surprising. Reported decreases in BMR with age are not large, and it may be difficult to observe differences over a relatively short experimental period. It also seems reasonable to assume that chronic stress requires an increase in energy metabolism to enable a rat to cope with a drastic change in environment. As BMR estimates were not obtained immediately following onset of stress and were not obtained at intervals throughout the experimental period, the hypothesis of increased energy metabolism due to stress remains a problem for future research.

The prostatic hypertrophy manifested by rats subjected to stress supports the "wear-and-tear" theory of aging. Herrington and Nelbach (10) have presented data that, according to them, show that the absolute and the relative prostate gland weights of rats 210 days of age are greater than prostate gland weights of rats 120 days of age. However, as Herrington and Nelbach did not subject their data to statistical treatment, their claim is difficult to evaluate.

In regard to the present study, two precautionary remarks are in order. First, the prostate gland is part of just one system, out of many systems, that supposedly wears out in the process of aging. Results discussed in this paper indicate that chronic stress is instrumental in causing one physiological sign of senescence; i.e., prostatic hypertrophy. Second, as found in senescent humans, benign prostatic hypertrophy is concurrent with nodular hyperplasia. In the present study, the author did not secure microscopic data on the cellular composition of prostate tissue. Positive cytological evidence would reinforce the conclusions reached.

The results discussed in this paper indicate that an animal's environment may "require" or "cause" adaptive responses that produce irreversible damage and hence shorten life span. A concept such as "normal" aging may be misleading, since aging cannot be represented as a unitary concept. Aging is the cumulative effect of responses made by biological systems as these systems adapt themselves to environmental stressors.

E. Summary

The hypothesis investigated in this study is that chronic stress initiates premature physiological aging. Aging was defined in terms of BMR and size of the prostate gland. Sprague-Dawley male rats were subjected to tone-shock pairs 20 hours daily for 24 days. Blood differentials and BMR estimates were obtained during the stress period and compared to prestress measures. Upon termination of the experimental period, adrenal and prostate glands were weighed. Rats under stress demonstrate eosinopenia and lymphocythemia. Rats under stress also exhibit larger adrenal-weight, body-weight ratios and larger prostate glands than rats not under stress. BMR differentials are not significant.

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SENESCENCE AND FIGURAL AFTEREFFECTS IN TWO MODALITIES: A CORRECTION*[1]

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A. INTRODUCTION

In a recent article (1), the authors examined the hypothesis that elderly persons are less susceptible to visual and kinesthetic figural aftereffects than are younger persons. The conclusion they reached was that ". . . senescence does not appear to have a pronounced effect either on susceptibility to, or time course of, figural after-effects . . . ." This conclusion was based (*a*) on the absence of significant differences between young adults and senescent individuals in visual or kinesthetic aftereffects at various intervals after satiation, and (*b*) on the absence of significant positive correlations between aftereffects in the two modalities: vision and kinesthesis. The authors interpreted their conclusion to be inconsistent with Rich's finding of negative correlations between figural aftereffects and age in elderly groups (2), and with Wertheimer's use of figural aftereffects as an index of "metabolic efficiency" (3).

Our data were collected by two assistants, A-1 and A-2, each of whom had been given detailed instructions. A check of the first few protocols obtained by each assistant raised no suspicion that precise measurements were not being made. Subsequent to the publication of the study, however, it became clear that one of the assistants had been suffering from a neurological disorder that affected visual functioning. We were led, therefore, to a reanalysis of the data. In this reanalysis, data collected by A-1 and A-2 were tabulated separately. The results are given in Figures 1, 2, and 3. Each figure shows visual aftereffects as functions of time allowed to elapse subsequent to inspection. Data are given for the total sample, as well as for old and young subjects, respectively. It can be seen that data collected by A-1 yield curves that show monotonic decrease with time. Data collected by A-2 yield curves

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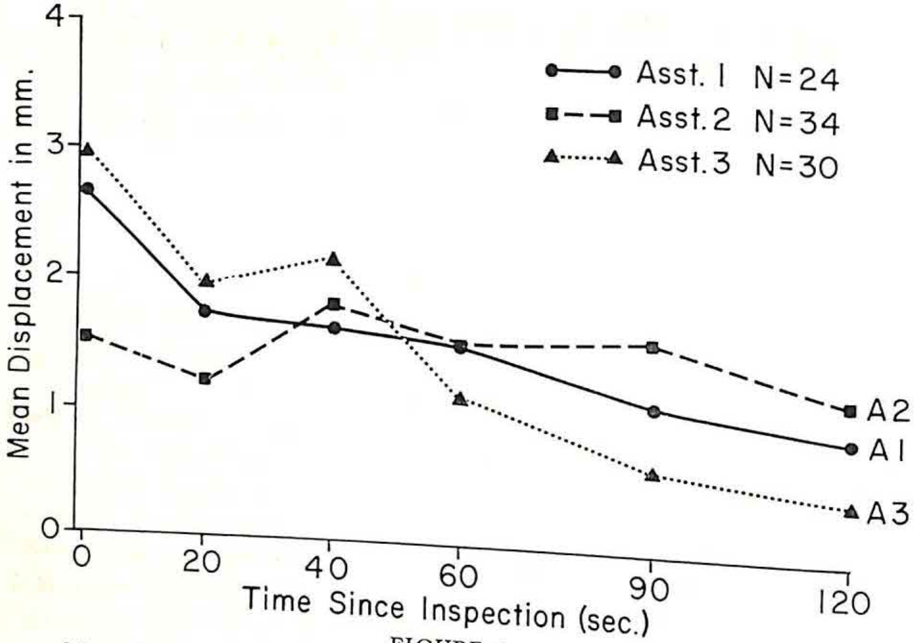

FIGURE 1
MEAN DISPLACEMENT AS A FUNCTION OF TIME SINCE INSPECTION FOR THE THREE ASSISTANTS: TOTAL SAMPLE

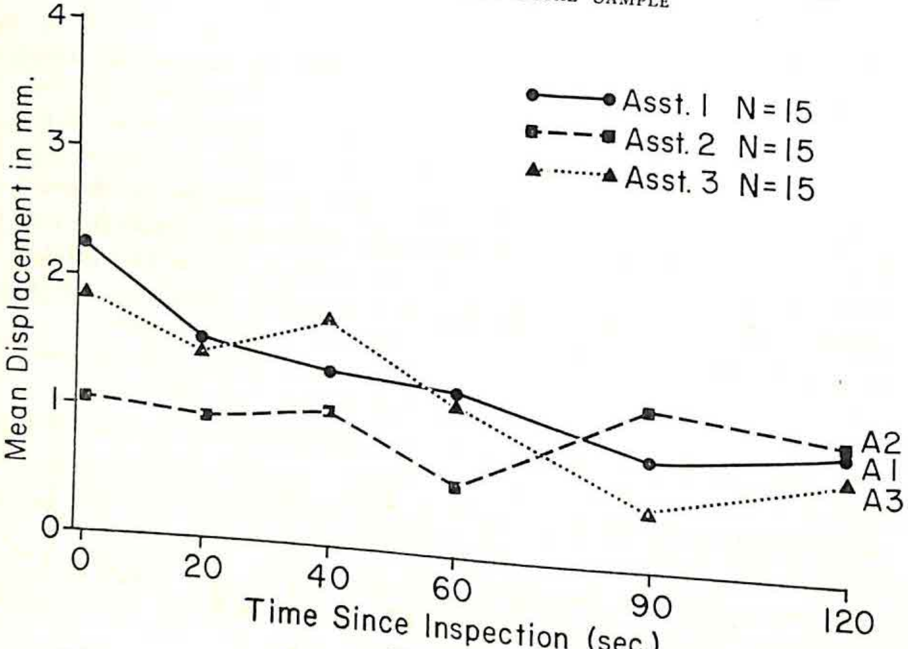

FIGURE 2
MEAN DISPLACEMENT AS A FUNCTION OF TIME SINCE INSPECTION FOR THE THREE ASSISTANTS: OLD *S*s

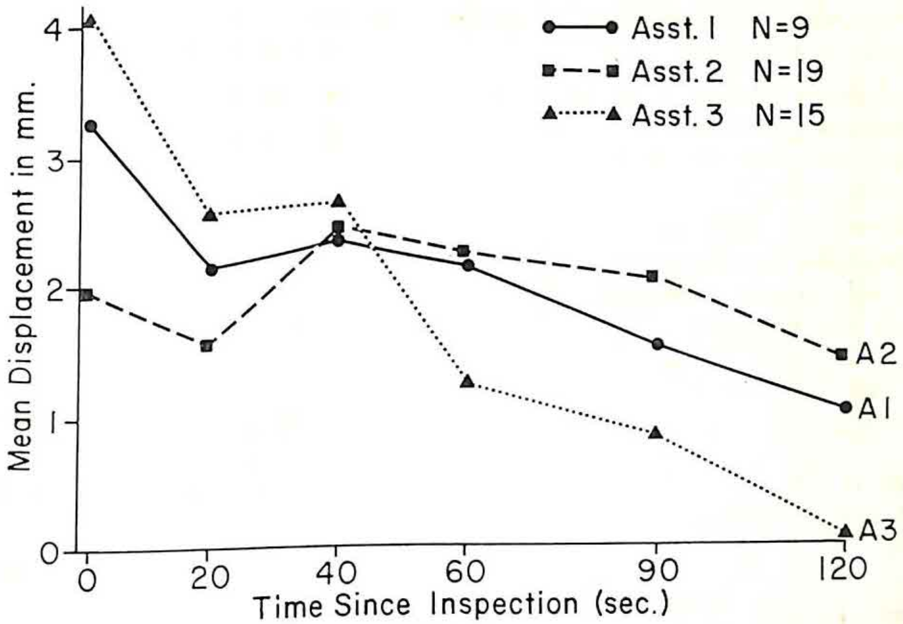

FIGURE 3
MEAN DISPLACEMENT AS A FUNCTION OF TIME SINCE INSPECTION FOR THE THREE ASSISTANTS: YOUNG *S*s

that are irregular approximations to a horizontal line. In view of the suspected unreliability of the measurements reported by A-2, a third assistant, A-3, was assigned to collect data.

B. PROCEDURE

Thirty new subjects, 15 young men (with a mean age of 20.8 years; $SD = 3.7$) and 15 senescent men (with a mean age of 66.1 years; $SD = 2.3$) were employed. These men came from the same source as had the earlier subjects. The procedure was the same as that described in the earlier paper. Data were collected by A-3.

C. RESULTS

Figures 1 to 3 show that curves based on measurements made by A-3 are similar in form to those based on measurements made by A-1. Based on measurements made (*a*) by A-1 and A-2, (*b*) by A-1 and A-3, and (*c*) by A-2 and A-3, three separate analyses were performed. In analyses (*a*) and (*c*)—i.e., in analyses that involved measurements by A-2—significant time × assistant effects were found: $p < .05$ for (*a*); $p < .01$ for (*c*). Such effects were not significant in the analysis that involved measurements made by A-1 and A-3.

A significant time × age effect was found only in the analysis that involved measurements made by A-1 and A-3. In that same analysis, the time effect was significant beyond the .001 level. No significant age effect was discovered. For the combined data of A-1 and A-3, the difference between old and young subjects was significant only at zero time. Data for A-1 and A-3 combined, presumably the only valid combination, are presented in Figure 4. Except at 120 seconds subsequent to inspection, aftereffects are higher for young men than for elderly persons. The largest difference is at zero time.

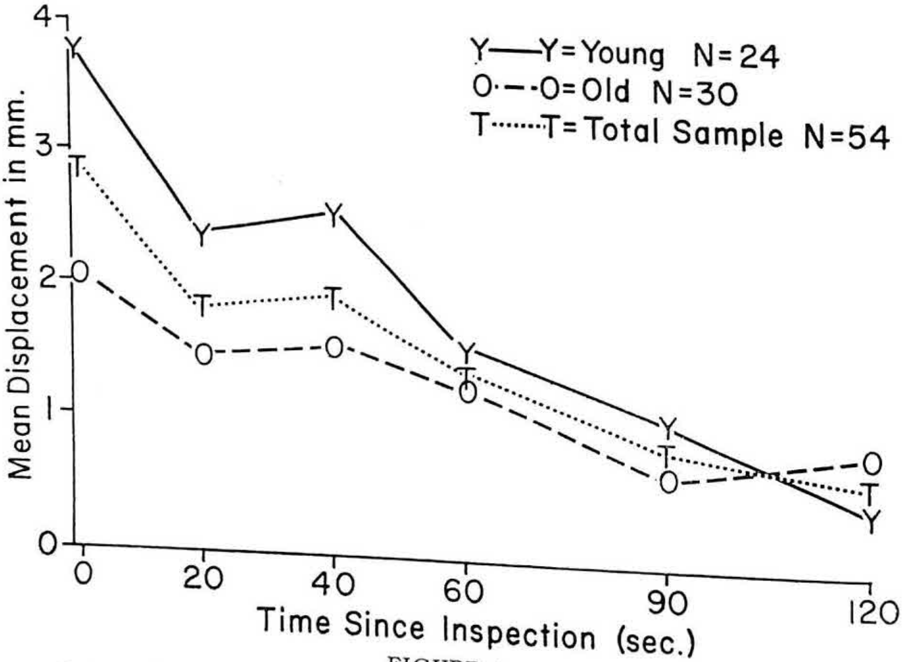

FIGURE 4
MEAN DISPLACEMENT AS A FUNCTION OF TIME SINCE INSPECTION FOR COMBINED DATA OF ASSISTANTS 1 AND 3

D. DISCUSSION

If the combined data of A-1 and A-3 had been available at the time the original paper was prepared, the authors should have concluded that senescent subjects have lower visual aftereffects than young subjects—at least for measurements taken immediately after inspection when aftereffects are maximal. To that extent our results would have been consistent with those reported by Rich (2), and with Wertheimer's theoretical position (3).

The authors have re-examined their original data on kinesthetic aftereffects and do not find them to differ systematically according to assistant. In the kinesthetic study, the scale had large black numbers that unquestionably were legible to A-2. Nevertheless, in view of the unreliability of the measurements made by A-2 in the visual study, it seems that we should conclude that our data in the kinesthetic study do not bear on any hypothesis. In any case, the absence in our original report of significant correlations between aftereffects in the two modalities must be considered meaningless. We regret the publication of erroneous conclusions.

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DIFFERENTIAL LATENCY OF ORAL RESPONSE ON THE FIRST DAY OF LIFE*[1]

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A. PROBLEM

The problem of this study was suggested by observations of 200 newborn infants. On days chosen at random, the youngest infant in a nursery was observed before and during the first feeding. Observations suggested that differences in infant self-stimulation in the nursery are associated with differences in reflex capacity as feeding begins. Hospital routine inadvertently separates the early part of the sequence of stimulation from the mother who feeds the baby. For reasons of safety, the neonate in American culture is an institution child for a brief period. Deprivation studies have implied that lack of sustained adult attention to individual infants in institutions and homes has been associated with lack of adequate care (3). This implication suggests that adequate performance of the child-care task may depend on contact with the infant at times other than during those tasks. The general hypothesis suggested is that optimum infant care for bodily function may be dependent on knowledge of the infant's action in the preceding time span.

Institution routine may separate the preceding sequence from the caretaking adult. In this event, the caretaking adult cannot participate in the preceding action or be directly aware of it and so may assist the baby less effectively. This is a reasonable hypothesis for the first feeding postpartum when the baby is 24 hours old.

The baby is taken from the nursery to his mother's room at feeding time. Infant and mother are dependent for safe infant feeding on infant reflex response to stimulation by the mother. If we assume infant "readiness" for the particular reflex response, the infant's capacity to respond will vary with the stimulation received. The infant may be unresponsive because unstimu-

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[1] This investigation was accomplished in the Department of Pediatrics, State University of New York, Upstate Medical Center, and was aided by a grant from the Ford Foundation. The author wishes to thank Dr. Julius Richmond for his support of the research and to express gratitude to Mrs. Jessie Lord, who first showed us how a skillful nurse may give her knowledge of an individual infant to that baby's mother.

lated, or maximally responsive, and then enter into a refractory state in which rest is necessary before the next response is possible. Prechtl (5) adds a fourth period in which the infant gives a contralateral response.

If part of the sequence has occurred in the nursery before feeding, the baby lacks cortical maturity to "adapt" his responses to adult stimulation that is not adjusted to his own reflex tempo at the moment. The adult must modulate the stimulation until it reaches the right level for the infant's response capacity at the time. We would expect the baby's response capacity to be a function of stimulation and response in the preceding period. Infant differences in reflex response may have many antecedents, including differentials in maturation, residual effects of maternal medication during labor, differences in parturition, differences in maternal handling, and differences in nursery-staff handling of the baby. This study suggests another possibility: differences in infant action before feeding.

The hypothesis of a sequence of infant action (related to the reflexes of feeding), which is a logical part of the adult-infant behavior of feeding, suggested questions amenable to investigation. (*a*) Could differential action in the prefeeding period in one nursery be demonstrated? (*b*) If so, was such differential action associated with subsequent latency of reflex response to oral stimulation?

A specific hypothesis for the questions just mentioned was not immediately apparent. Observation had suggested that duration of self-stimulation (hand-body contact) is significantly related to latency of reflex response. Time can be measured with the required precision on film. However, the durations of contact measured on film are imprecise in an anatomical sense. Actual contact of hand and body can seldom be demonstrated on a two-dimensional film plane. Lines between body regions cannot be defined with precision in the moving infant. Therefore, in the adopted procedure: (*a*) criteria were defined as hand-mouth contact and hand-hair contact, and (*b*) an attempt was made to find, by experiment, what postural relationships are associated with these criteria.

Posture or the relative position of body parts in the film plane may be measured with great precision. Therefore, our hypothesis is that the posture associated with criteria of body contact will also be associated with latency of subsequent response to oral stimulation.

B. METHOD

1. *Subjects*

On each of 28 randomly chosen days, a subject was selected. On each day this subject was the first baby to be admitted to the nursery who was designated normal, had been delivered without complication, and was to be bottle fed. In one series, Experiment I, observations were made on 13 babies in their first day of life. In a second series, Experiment 2, observations were made on 15 babies. Six of the 15 babies were in their first day of life. Nine were in their second day of life.

2. *Equipment*

A 16-mm moving picture camera with wide-angle lens and a microchronometer, both on tripods, were used for recording behavior samples. One switch started the camera and the microchronometer simultaneously. A time-and-motion study projector was used for film analysis.

3. *Procedure*

Normal hospital nursery routine was left unchanged. Infants spent the first day in the nursery. None was fed. None was seen by his mother. All infants received similar care by the same nursery staff. Each infant lay in his crib on his left side, supported by a rolled pad along his back. Four hours of quiet (with no handling) preceded the test which began at a routine hospital feeding period (2 a. m.), when clothing is routinely changed. Soiled clothing was removed and the baby was rolled in his own crib a few feet to the camera. The camera, at the head of the crib, was focused on the infant's head and the microchronometer beside the crib, and recorded a 0.48-minute standard time sample which has been described elsewhere (1).

Briefly, a prestimulus period of 0.16 minute of spontaneous activity was followed by a stimulus period. The stimulus was a skin-to-skin moving contact of a finger to the baby's right cheek. Starting at the ear, the stimulus-finger moved to the median line of the lips and back to the ear. Stimulation was repeated three times in .16 (± .03) minute to form continuous movements of stimulation.

The reflex response was defined as the movement of the infant's mouth toward the right side of the crib while the moving stimulus was in the last three-tenths of its traveling time from ear to lips. If more than one movement occurred, the reflex response was the movement that occurred as stimulation was nearest the median line. The response involved movement against gravity and against the force of the moving stimulus. There was no control for inhibition of the response by the force of the stimulus.

In Experiment 1, at five-minute intervals, two observations (motion pictures) of the same length were taken. The second period was without a contact stimulus. In Experiment 2, stimulation was repeated continuously as the baby was aroused and until his movement became as rapid as the movements of stimulation, or until he fell asleep. Since infants do not make hand-mouth or hand-hair contact in all samples, we have disregarded all observations prior to the period in which the first contact occurred. Hand-body contact, posture, and latency of reflex response to tactile stimulation were analyzed from film by means of a time-and-motion study projector that threw images onto a mirror that reflected them to a ground-glass screen on the desk beside the projector.

4. *Criteria*

Our criterion definitions were as follows:

1. *Hair* was the head region with hair dorsal or posterior to the ear, and cranial or superior to the ear.

2. *Mouth* was the perioral region between the nostrils and the chin (mentum), and was bounded on each side by a line through the center of the eye parallel to the nose.

3. *Contact* occurred when the right hand obscured or was obscured by hair, or when the right hand obscured the mouth, unless the shadow indicated otherwise (i.e., there was a light area between shadow and hand). Nursery lighting was from the ceiling (3.4 lumens at the baby's face, as measured by light reflected from a flat white card).

4. *Latency of reflex response* was the traveling time of the stimulus from the baby's ear across the cheek until the beginning of the predicted response.

5. *Posture* was defined by the position of the right hand ventral or dorsal to the ear. By means of a transparent ruler laid over the film image, a line was established (through the tragus of the ear) that was parallel to the dorsal margin of the body as seen on the film (a line from shoulder to hip). If the right hand lay dorsal or posterior to this line, it was dorsal in position; if ventral to the line, it was ventral in position. If any part of the hand touched the line, the hand was parallel to the ear.

5. *Reliability*

The film was analyzed by the experimenter and two assistants. Ten per cent of the film strips, chosen at random, were analyzed for reliability. Rater agreement for duration of contact was (*a*) hand-mouth, 93.3 per cent, and (*b*) hand-hair, 93.9 per cent. Agreement for duration of hand posture was 91.0 per cent.

6. *The Specific Hypothesis*

As the infants roused before their first feeding period, few of them touched both mouth and hair within 0.1 minute. Therefore, the 0.1 minute immediately preceding the stimulus period was chosen as a base or standard behavior period. On the basis of total contact found in two behavior samples for each baby, an association is shown between the body areas touched and the baby's posture throughout the observational period.

Longer mouth contact was associated with longer ventral hand posture. Longer hair contact was associated with longer dorsal hand posture.

According to Fisher's exact probability test (4, pp. 96-97; 7), each of the relations is significant beyond the .01 level.

As the sample length that gave independence of hair contact and mouth contact was not predicted but was found on the basis of our observational data, the relationships were tested again in another group of infants. In Experiment 2, the first period in which the baby made hand-body contact was chosen as the contact sample. Behavior in the contact sample was then related to the posture throughout the first sample. Again (beyond the .001 level of confidence) infants who made more mouth contact showed more ventral hand posture and infants who made more hair contact showed more dorsal hand posture. Thus, babies who show posture with more ventral than dorsal right-hand position differ from other babies with respect to latency of the first response to oral stimulation.

C. RESULTS

By posture assumed during a time-behavior sample, infants less than one day old are divided before their first feeding into two groups (ventral or dorsal hand position of 0.1 minute) with respect to latency of subsequent reflex response to oral stimulation ($t = 2.47$; $df = 11$; $p < .05$).

On the infant's first day of life, differential posture is associated with a specific level of latency of subsequent response. Greater duration of ventral hand position is associated with a latency of response of less than .02 minute. Duration of other hand positions (dorsal and parallel) is associated with a latency of more than .02 minute.

Figure 1 shows the latency of reflex responses in relation to age (one to four days). For the babies who show more ventral than dorsal hand posture, latency is lower on each succeeding day. The difference is greatest on day one before the first feeding. The coefficient of variation shows changes over the four days. On days one and two, infants are less variable than on days three and four. After day two, variability rises sharply with the age of the babies.

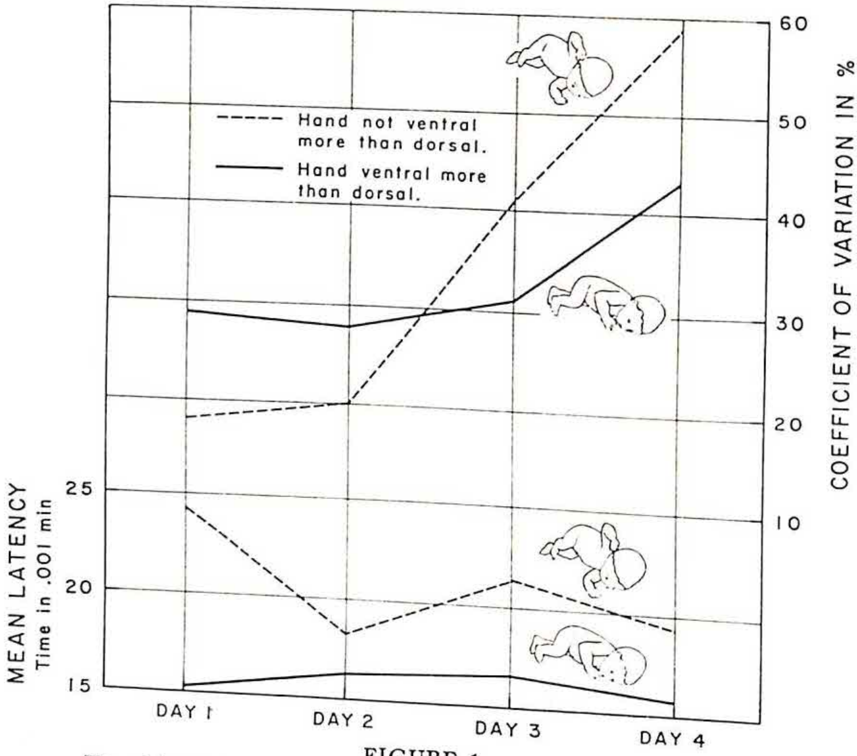

FIGURE 1
TWO TIME SERIES OF NEONATE RESPONSE TO ORAL STIMULATION FOR TWO GROUPS OF INFANTS
(Mean latency and coefficient of variation)

D. DISCUSSION

The results of this study suggest that optimum stimulation for feeding is not the same for all babies. Without knowledge of an infant's action during a preceding sequence, the adult trying to feed an unresponsive baby cannot know whether the baby is unstimulated and requires much stimulation or whether the infant is refractory and should have no stimulation. Our data support the hypothesis that sequences of infant action significant to bodily function may be inadvertently separated by institution routine from the adult upon whom the infant is dependent for assistance with the function in question.

The antecedents of postural differences associated with the latency of response in infants are unknown. Posture in utero, the effects of parturition on the newborn, and conditioning in utero are possible explanations for variance of response on the first day of life. Such variation may also be the nonrandom result of random postural differences under the force of gravity. Hand and head are distal to other parts of the body, and their position is an expression of the interrelationships of any or all of the parts. The relationship of head and hand dictates what body region will be touched and manipulated by the baby. The force of gravity may dictate that wherever the baby's hand first falls will be the region in which it tends to stay.

Should the "preference" for an area of hand contact prove stable over time in a group or in individuals, the possibility of sensory preconditioning is suggested (6). One may speculate whether two groups of infants with different levels of oral response at feeding would condition differently to the feeding process.

Why does association between posture and latency occur? Possibly the "self-contact" associated with posture is a differential self-stimulation. Such an hypothesis suggests that intersensory interaction as a mode of communication between mother and infant is developed in child-care tasks.

E. SUMMARY

Neonate infants show differences in posture associated with latency of response to buccal stimulation. This occurs in the first day of life before the first feeding.

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ADOLESCENT PERSONAL PROBLEMS AS A FUNCTION OF AGE AND SEX*[1]

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A. INTRODUCTION

The problems of adolescents have been of interest and concern to parents and educators for many years. Although numerous techniques have been used to investigate the problems, the most common procedure has been to use the problem inventory or checklist. Typically a checklist describes a number of specific problem situations and the respondent is asked to check those items that worry him or best describe him. In order of publication date, typical studies are those by Symonds (7), Cheney (1), Elias (2), Morris (5), and Hayden (4). As Symonds has noted, the check-list procedure may require the respondent to indicate what he feels *should be* of importance or of major concern, rather than to indicate *what is* of importance or major concern. Other investigators have used the interview (8), projective techniques (3), and essays (6) to study adolescent problems.

From the studies mentioned, as well as from other studies, it would seem that between one-third and one-half of the school population are anxious about academic work. Health problems are checked frequently on problem lists, but they are seldom mentioned in essays. Girls are more concerned than boys with school problems, family relationships, and social adjustments. Boys, on the other hand, are reported to be more concerned than girls with finances and vocational plans.

B. THE PRESENT STUDY

The author investigated adolescent problems for several reasons. First of all, it seemed that the problem checklist approach, which has been used in many studies, has definite limitations. It does not show whether a respondent checks a problem because he feels that it should be a problem or because it is a problem. Further, the typical procedure does not give satisfactory indica-

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[1] This study was supported by a Bolton Fund Grant from Temple University.

[2] Visiting Professor of Psychology for the academic year of 1963-64 at the University of Puerto Rico, Rio Piedras, Puerto Rico.

tion as to whether a problem is a major problem or one that gives the individual little or no difficulty. Second, many studies have combined data on males and females or have reported data on one sex only, so that sex differences have been difficult to ascertain. Third, few studies have a wide age range; hence it has been difficult to observe whether problems change as a function of age. Fourth, as the author is engaged in counselor training, it seemed worthwhile to investigate the types of problems that a counselor reasonably might expect to find of major concern to counselees.

C. Procedure

What problems are of major concern to adolescents? To get answers to this question, approximately 4,000 boys and girls from over 30 schools were asked to report the biggest personal problem that was causing difficulty. The respondents were predominantly enrolled in the schools of Philadelphia and the surrounding suburban communities. As Table 1 shows, respondents ranged in age from 10 to 19.

TABLE 1
Numbers of Students by Age and Sex

Age	Males	Females
10	80	88
11	263	268
12	328	287
13	251	213
14	176	170
15	190	238
16	237	207
17	280	220
18	196	127
19	50	60
Total	2051	1878

Teachers administered a questionnaire on which four questions were asked. Students were instructed not to sign their names, but were asked to indicate age and sex. Further, in their replies, students were instructed to be as frank and as honest as possible. The questions asked were as follows:

1. What problem do you have right now that you think is a big problem? In other words, what is the biggest personal problem which may be causing you some difficulty?

2. What would be of greatest help to you in solving this problem? Or, to put it another way, if you had the power to solve this problem, how might it be solved?

3. What do you think is the biggest problem for other boys and girls of your age?

4. How do you think this problem might be solved?

The last two questions were asked on the theory that, while students might have some reluctance to list their own personal problems, they might project their problems to members of their peer group.

D. Results and Discussion

With the exception of a slight tendency for students from suburban communities to list more academic or school problems than other students, there was remarkable agreement among students of the same age and sex, regardless of school. For this reason, data from different schools were combined for tabulation.

It was found that respondents' answers could be categorized into 14 areas. Answers were analyzed by age and sex; however, because presentation of data by age and sex would involve lengthy tables, results by sex alone are reported (Table 2).

TABLE 2
Percentage of Personal Problems Reported by Problem Area for Self and Peers by Total Male and Female Groups*

Problem area	Self		Peer	
	Male	Female	Male	Female
School	35	23	21	14
Interpersonal	12	19	23	33
Maturity	2	3	2	7
Emotions	2	4	2	3
Work	6	5	7	6
Sports and recreation	4	2	5	2
Health	2	4	2	2
Ethical	1	2	1	2
Family	10	22	8	17
Habits	0	0	1	1
Finances	10	4	7	4
Unclassifiable	8	6	8	3
No answer	4	3	13	6
No problem	4	3	0	0

* For the males $N = 2051$; for the females $N = 1878$.

Problem areas as listed in Table 2 do not reveal the types of problems that fall within each category. Consequently, there follow some general comments on the types of answers given in each category. In each case, major age and sex differences are noted.

1. *School*

The overwhelming majority of school problems were on difficulties in academic work. There were a few unfavorable comments on problems with teachers. Approximately one-third of the boys and one-fourth of the girls reported that their greatest personal problem was some academic difficulty.

From the 11th year on, the academic problem was the major area of concern for boys. It was of less concern for girls. This result is not consistent with a consensus derived from earlier studies. In earlier studies, the female consistently has been more concerned that the male with academic problems.

Several explanations for the discrepancy occur to the author. First, it is possible that the discrepancy is due to differences in the population sample or in the techniques used. This does not seem likely; other studies have involved many different procedures with different populations, but consistently indicate that females are more concerned than males with academic work.

Second, it is possible that emphasis upon engineering, science, and the pursuit of a college education has changed or is changing the attitude of the adolescent male toward academic achievement.

Third, it is possible that increased emphasis upon college preparation has placed on tenuous ground the individual who is willing to settle for a "gentleman's C." Perhaps there has been an upgrading of standards that has made it more difficult or less acceptable to "get by" with a minimum expenditure of effort. Many educators have observed that there is less peer-group disapproval for an achieving girl than for an achieving boy. The boy's peer-group approval tends to come from areas such as athletics. Consequently, if standards or expectations for academic achievement have been raised, the male may have just cause to be concerned.

Regardless of the reason for their concern, boys viewed academic work as their biggest problem. They also considered it an area of major concern to their peers.

2. *Interpersonal Problems*

Interpersonal problems were with other people in general, with members of the opposite sex, and with the respondent's peer group. In this area, girls were much more concerned than boys, but both boys and girls saw problems in this area as of greater concern to their peers than to themselves.

Problems of adjustment with respect to the opposite sex and with respect to the respondent's peer group received the majority of responses. After age 13 or 14, there was a distinct tendency for problems with one's peers to decrease. This was true for both sexes.

Problems with the opposite sex were reported more frequently by girls than by boys and remained relatively constant for both sexes until the age of 16 or 17. After 16 or 17, problems with the opposite sex decreased markedly.

3. *Maturity*

Recognition of maturity was not a major problem for either sex, but it became a minor problem for girls as early as age 10. It did not occur to any degree for boys until age 13. Lack of parental recognition of maturity caused the greatest number of responses in this area. Less frequently mentioned were lack of recognition of maturity by persons other than parents, and immaturity in one's self.

4. *Emotions*

Problems of moodiness and lack of self-understanding and confidence were minor, but girls reported about twice as many problems as boys; there was some indication that such problems increased in seriousness at 18 or 19 years of age.

5. *Work*

Problems of work were of about equal concern to both sexes. Up to the age of 14 for boys and up to the age of 15 for girls, problems of work were seldom mentioned. From 14 or 15 to 17, problems were the finding of part-time work and the choice of a vocation. After age 17, the choice of a vocation was the major problem for both sexes.

6. *Sports and Recreation*

Twice as many boys as girls reported problems of sports and recreation. Boys listed more problems than girls with respect to leisure time, learning to drive (from age 15), and athletics. Difficulties with hobbies were listed by both sexes at the earlier ages. A few boys listed difficulty in learning to dance.

7. *Health*

Although health is not an area of major concern for either sex, girls list twice as many problems as boys. The difference between the sexes can be accounted for chiefly by the girls' concern with problems of weight, particularly between the ages of 11 and 14. Problems concerning skin blemishes and general appearance occurred in about equal frequency for the two sexes, usually prior to age 15. Both sexes made minor mention of family mental and physical health problems.

8. *Ethics*

Problems in ethics are of minor concern, but were mentioned more frequently by girls than by boys. At almost all ages, girls mentioned problems of religion and problems in the formulation of moral standards. Boys reported religious problems infrequently.

9. *Family*

Family problems—i.e., relations with either or both parents or with siblings—were of major importance to girls. Girls listed twice as many problems with siblings as did boys. For both sexes, sibling problems were most frequently mentioned prior to age 14.

When the boys mentioned a parental problem, they reported the problem as one that involved both parents. On the other hand, girls, while exceeding boys in mention of problems that involved both parents, frequently mentioned difficulties that involved only one parent (usually the mother).

10. *Habits*

Smoking and drinking were mentioned, but problems in this area seemed practically nonexistent.

11. *Finances*

The problem most frequently mentioned in this area was personal finance. Boys listed the problem twice as frequently as girls did. Other problems concerned family finance and anticipated expenses for college attendance. As might be expected, mention of financial problems increased with age.

12. *Miscellaneous*

One boy reported that he had robbed a store the previous night (and signed his name), but problems of this magnitude were exceedingly rare. Some students did not complete the questionnaire. Some students apologetically said that they had no major problems.

For both sexes, the per cent of students who stated that they had no problems decreased sharply after age 14. On the basis of the literature which has indicated that girls have more problems than boys, it might have been expected that more boys than girls would report that they had no problems or would not answer the questionnaire. Of course, as some studies have implied, it may be that the girls' problems were more severe and more numerous. As the present study asked only for the "biggest" single problem, it sheds no light upon the possibility just mentioned.

13. *Problems of Peers*

Both sexes see their peer groups as having fewer school problems and as having more interpersonal problems than they report for themselves. Whether or not this perception represents a projection of problems that boys and girls are unwilling to admit for themselves is a matter of conjecture.

14. *Solutions*

Table 3 summarizes the manners in which the subjects suggested they could solve their problems. A solution was *extrinsic* if it involved receiving help from some outside source—e.g., "getting my parents to help me with my homework." A solution was *intrinsic* if the individual suggested that he, himself, could solve the problem—e.g., "spending more time on my homework." If the solution was extrinsic *and* intrinsic, it was placed in a *combination* category. Unrealistic answers were put in a *fantasy* category—e.g., "if someone would give me 20 million dollars." Answers which were thought to indicate that the respondent was not seriously trying to give a solution were placed in a *flippant* class.

TABLE 3
PERCENTAGE OF SUGGESTED SOLUTIONS GIVEN FOR PERSONAL PROBLEMS OF SELF AND PEERS OF TOTAL MALE AND FEMALE GROUPS*

Solution	Self Male	Self Female	Peer Male	Peer Female
Extrinsic	26	29	34	41
Intrinsic	35	33	26	23
Combination	8	12	8	14
Fantasy	5	4	1	0
Flippant	4	1	2	0
Unclassifiable	4	2	2	2
No answer	12	10	17	11
No solution	6	9	10	9

* For the males $N = 2051$; for the females $N = 1878$.

For both sexes, there was a tendency for extrinsic solutions to increase with age (Question 2). Intrinsic solutions tended to decrease with age for girls and tended to remain relatively stable for boys. Both sexes tended to list more extrinsic solutions for problems of their peers than they did for their own problems. For peers, there was also a tendency for extrinsic solutions to increase with age and for intrinsic solutions to decrease with age.

E. SUMMARY

A questionnaire was given to approximately 4,000 students who ranged in age from 10 to 19. They were asked to list their own biggest personal problem, their peer group's biggest personal problem, and the ways in which these problems could be solved. Most frequently mentioned were school, interpersonal, financial, and family problems. Sex differences were found in that boys reported more problems in school and more financial problems than girls; girls reported more interpersonal and family problems than boys.

Approximately one-third of the boys reported academic difficulty in school as their major problem. Ten per cent mentioned interpersonal, family, and financial problems. School, interpersonal, and family problems accounted for 60 per cent of the problems listed by girls. Both sexes saw their peer group as having fewer school problems and as having more interpersonal problems than they reported for themselves.

There was a tendency for extrinsic solutions to problems to increase with age for both sexes, and for intrinsic solutions to decrease with age for girls but to remain relatively constant for boys. For their peers, both sexes suggested more extrinsic solutions than for themselves and fewer intrinsic solutions.

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AN EMPIRICAL CONCEPT OF REINFORCEMENT AND A FUNCTIONAL ANALYSIS OF CHILD BEHAVIOR[*][1]

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A. INTRODUCTION

The purpose of this paper is twofold: (*a*) to discuss the empirical concept of reinforcement in relation to a theory of psychological development, and (*b*) to present examples of research with children based upon such an orientation.

The meaning of an empirical concept of reinforcement for a theory of child development cannot be appreciated in isolation. Reinforcement is not thought of as a kind of learning theory (such as reinforcement learning theory) or as a miniature behavior theory. It is viewed as a significant statement concerning the temporal relationships between certain classes of stimuli and responses; therefore, this discussion is preambled with an outline of a theory of development that involves an empirical concept of reinforcement (9).

B. A CONTEXT FOR AN EMPIRICAL CONCEPT OF REINFORCEMENT

Data of psychological development are viewed as progressive changes in behavior (i.e., as differentiations and increases in complexity) that evolve from interactions with the environments of development. The phrase "environments of development" refers to *stimulus events.* Stimulus events include circumstances that *have* interacted with the developing organism (historical) as well as those that *are* interacting with it. Stimulus events may be described by their functional properties *and* by their physical properties. For example, a tone may be characterized by changes in electrical impulses on an oscilloscope and, at the same time, by specific changes in the behavior of an organism. With respect to its relationship with behavior, the onset of the tone may be correlated with an orienting reflex, with a response that has been reinforced in the past, or with an increase in strength of a response that preceded it (as observed in the future occurrences of responses of the same class). Thus the tone may be described by one or by several functional characteristics; it may also be described by its physical dimensions, such as wavelength, amplitude, and composition.

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Many stimulus events influence the strength of specific stimulus-response relationships. Such stimulus events are *setting events* or setting factors.

> Such setting factors as the hungry or satiated condition of the organism, its age, hygienic or toxic condition, as well as the presence or absence of certain environing objects clearly influence the occurrence or non-occurrence of interbehavior or facilitate the occurrence of the activities in question in varying degrees (20, p. 95).

Consider the example of hunger or, better still, the deprivation of food as a setting event in the eating behavior of a 10-year-old boy. The training that the boy receives relative to food and to members of the family around the table is in part a function of food deprivation for about four-and-a-half hours prior to coming to the table. Fasting for four-and-one-half hours between meals is a setting event that plays a role in the learning supervised by the boy's parents. When this setting event is changed, the boy's behavior is altered. If we were to observe the boy's eating behavior under conditions of a setting event of only one hour since he last ate, we would be likely to say that his table manners were "poor" or that he exhibited low frequencies of "approved" behaviors and high frequencies of other kinds of behavior. (He spends most of his time "playing with his food.") If we were to watch him under conditions of a setting event of seven hours of food deprivation, we would also be likely to say that his table behaviors were "poor," or that he exhibited low frequencies of "good" behaviors and high frequencies of still other kinds of behavior. (He "devours his food.")

We turn now to an empirical concept of the child as a psychological organism. The developing child may be considered equivalent to a constellation of stimulus and response events. Stimulus events inside the organism are viewed as part of the environments of development and are analyzed in the same manner as external stimuli. No new assumptions are invoked. Because of the frequent inaccessibility of internal stimuli, adherence to an objective conception of them poses special, but not insurmountable, problems for a natural science approach.

The response aspect of the child is analyzed in terms of its physical and functional properties. From the point of view of physical analysis, responses are described by space-time dimensions, such as latency, frequency, and amplitude.[2] From a functional vantage point, responses are described by their relationships to stimuli. To say that a stimulus has a stimulus function is to say that it interacts with a psychological response, a response that involves the organism as a unified system. The response in the interaction is said to have a response function.

Psychological interactions may be divided into two categories on the basis of temporal relationships. One group consists of interactions that vary in strength in accordance with antecedent stimulus action; the other group consists of interactions that vary in accordance with consequent stimulus action. Skinner (34) refers to the first group as operants; to the second, as respondents. Such a classification may be used advantageously to analyze the continual interactions between the developing child and environmental changes divided into stages. An analysis of development in terms of operant and respondent interactions throughout all developmental phases would be in contrast to approaches that view development as changes in motor, linguistic, intellectual, emotional, and social patterns of behavior. The difficulty with schemes of the latter sort is that they are based on shifting and overlapping criteria (physical, social, physiological, etc.), some of which are objectively defined and some of which are not. Furthermore, the specific stimulus functions that are involved (the environmental situations to which they are related) are ignored or minimized.

The other aspects of the systematic and empirical theory of development concern the strengthening and weakening of stimulus-response relationships, interrelationships between operant and respondent processes, generalization and discrimination, differentiation, chaining, conflict, and self-control.

The aim of the approach is to observe, analyze, and interpret interactions between environmental events and responses so as to extend and refine empirical laws. Accomplishments to date have contributed to an objective theory of development and have provided some principles for educational and child-rearing practices.

C. An Empirical Concept of Reinforcement

So much for a theoretical frame of reference. We now turn to a discussion of an empirical concept of reinforcement within the context given. At the outset, it should be noted that the concept of reinforcement (empirical and other) is believed to hold only for operant interactions. The concept may be stated as follows:

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[2] Data from a particular study will, of course, depend upon the dimension selected (17).

> [A certain class of behavior is strengthened by certain classes of consequent stimulus events.] The only way to tell whether or not a given event is reinforcing to a given organism under given conditions is to make a direct test. We observe the frequency of a selected response (operant level) then make an event contingent upon it and observe any change in frequency. If there is a change, we classify the event as reinforcing to the organism under the existing conditions (35, p. 73).

One may ask, "Why does a stimulus with reinforcing properties strengthen such behavior?" Some points of view seek an answer in terms of biological or biochemical inferences and data (the reductionistic approaches); some, in terms of hypothetical variables (usually some variation on a drive-reduction notion); still others, in terms of consequent feeling-states. A natural science approach avoids these kinds of attempts at explanation. It accepts the fact of reinforcement.[3] It accepts the fact that a class of objectively defined responses is strengthened by consequent environmental events. It accepts the fact that such events are of two sorts: one sort strengthens on presentation; the other, on withdrawal. Environmental events in the first group are called *positive reinforcers* to emphasize the adding operation; environmental events in the second group are called *negative reinforcers* to emphasize the subtracting operation. A detailed account of the empirical concept of reinforcement involves the procedures for weakening operant behavior (19, 21, 34, 35).

Instead of searching for the correlates of operant strengthening in the neighboring branches of science or of constructing "explanatory interval variables," the empirical approach emphasizes the need for systematic information on the empirical relations between reinforcing stimuli and operants. For example, many investigators are exploring the range of reinforcing stimuli applicable to the young infant (primary reinforcers), the time of the initial appearance of certain operants, the processes and circumstances under which neutral stimuli take on reinforcing functions (acquired reinforcers), and the patterns of interactional contacts between reinforcers and responses (schedules). One of the major tasks in an experimental analysis of child behavior and behavior development is the discovery of stimuli that have positive or negative reinforcing properties for children at different stage levels, and a delineation of their parameters together with their relevant setting events.

In passing, it should be noted that the empirical concept of reinforcement is similar to Hilgard's "neutral definition" of reinforcement (18). There is a difference, however. Hilgard's conception applies to responses that acquire their functions through consequent stimulation (operants) *as well as* through antecedent stimulus action (respondents). Here, the empirical concept of reinforcement does not apply to respondent behavior. It is true that under proper circumstances, operants, as well as respondents, correlate with antecedent stimulation, but these functional relationships are established through different histories. Because each class of interactions has a different history and the stimuli and responses that are involved have different functions, separate analysis is indicated. In the interest of clarity, it is suggested that the empirical concept of reinforcement be restricted to interactions controlled by consequent stimulation and that, as suggested by MacCorquadale (27), Schlosberg (33), and Skinner (34), a different term be applied to interactions controlled by antecedent stimulation.

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[3] The argument that this position "postulates the problem" is relevant only when one assumes that "causes" in the behavior science must be in terms of variables from biology, biochemistry, etc.

D. Examples of Research with Children

During the past four years, examples of research with children from the point of view of an empirical concept of reinforcement have become more available. Some investigations, as they must in initiating an experimental approach, have been devoted to exploration of the physical features, methods, procedures, and techniques appropriate for the laboratory study of children of all ages. Thus Bijou (5, 6) and Baer (3) have worked on a methodology for normal preschool children. Bijou was concerned with general laboratory techniques; Baer was concerned with specific procedures for analysis of verbal-social stimuli that involved an animated, talking puppet. Long, Hammack, May, and Campbell (23) and Long (22), have concentrated on laboratory methods for preschool children and, particularly, for middle-childhood children. Ellis, Barnett, and Pryer (12) and Orlando, Bijou, Tyler, and Marshall (31) have explored methods appropriate to retarded children in a residential school, and Ferster and DeMyer (13) have made intensive investigations on procedures appropriate for young autistic children in a hospital setting.

Another group of studies, and a rather large group, has been devoted to the specification of reinforcing stimuli for neonates, infants, preschool children, and older children, as well as to the patterns of behavior that are associated with the basic schedules of reinforcement. In a way, this area of inquiry is continuous with methodological investigations because such information is essential to the planning and execution of all studies. In striving to produce reliable relationships, these studies make explicit the reinforcers in operation and the schedule with which they are presented or withdrawn. Some investigators have taken leads from studies on infrahuman subjects;

other investigators have explored new contingencies. For example, Bijou (7) has studied the presentation of positive reinforcers by comparing continuous and intermittent schedules on preschool children. Long (22) has studied fixed ratios, fixed intervals, and variable intervals. Ellis, Barnett, and Pryer (12) and Orlando and Bijou (30) have studied basic intermittent schedules with retarded children. Ferster and DeMyer (13) have studied intermittent schedules with autistic children. Examples of studies on the loss of positive reinforcers (withdrawal of short intervals of cartoon movies) include those by Baer (2, 3) on escape and avoidance behavior in normal preschool children, and by Marshall (28) on institutionalized retarded subjects.

A third group of investigations has been concerned with the response functions of normal and deviant children of varying ages. For example, Brackbill (11) wondered whether the smiling behavior of six-month-old babies has operant properties. Rheingold, Gewirtz, and Ross (32) asked a similar question about the vocalization of infants. The provocative findings from both of these investigations open the way for a host of new studies. In the same vein, Flanagan, Goldiamond, and Azrin (14, 15) sought to learn whether stuttering can be conditioned according to operant principles. Their encouraging results have new implications for this recalcitrant problem area.

A fourth group of studies has been devoted to setting events; i.e., to circumstances that influence the relationships in a specific psychological interaction. Included in this group are studies by Gewirtz and Baer (16) on the effects of satiation and deprivation of social stimulation on a task reinforced by social stimuli, and by Lovaas (24) on the influence of exposure to symbolic aggression on aggressive behavior in normal preschool children.

A fifth group of investigations centers around problems of discriminative stimuli (stimulus control, cues, perceptual stimuli). Studies on the acquisition and stability of multiple schedules by Bijou (8) on normal children and by Bijou and Orlando (10) on retarded children are of this nature. The influence of verbal behavior on other verbal behavior and on nonverbal behavior, as studied by Lovaas (24, 25), are also pertinent. The laboratory study by Azrin and Lindsley (1) on cooperative behavior also falls in this category. In this last-named study, the cue for the behavior of the "follower" was an objectively defined response by the "leader."

There are several clearly apparent trends in the work of investigators who are following a natural science theory of development that embodies an empirical concept of reinforcement. They may be mentioned briefly. First, the work of such investigators shows a strong interest in adding to an empirical theory of development rather than in testing deductions from a formal theory. Second, there is a preference for laboratory-experimental studies. Third, there is a tendency to study individual children intensively and to seek control of variables through laboratory procedures rather than through psychometric procedures. Experimental design by laboratory control is not indigenous to this approach but is attractive, since many investigators believe that individual analysis is an ultimate objective of a behavioral science. One correlate of this practice is the preference for a standard laboratory situation for all studies, using variations of stimulus or response functions pertinent to the particular study. A second preference is for analysis in free operant situations (rather than under restricted operant conditions as is exemplified in the WGTA) because free operant situations allow for greater control and provide more detailed and continuous information.

E. SUMMARY

The empirical concept of reinforcement as related to child development has been discussed in the context of a theory from a natural science point of view. The position states that the data of psychological development are progressive changes in behavior (differentiation and increases in complexity) that evolve from interactions with the environment of development. The environments of development consist of stimulus events and of setting events. Stimulus events are stimuli that are described by physical and functional procedures; setting events are operations that affect specific stimulus-response interactions. The developing child is said to be a series of stimulus and response events. The stimulus aspects of the child (internal stimuli) are analyzed in the same way as those in the external environment. The response aspect is also described by its physical properties (frequency, amplitude, latency, etc.) and by its functional properties (whether they are controlled by stimuli that precede or follow them). The former are called respondents, reflexes, or involuntary responses. The latter are designated as operants, instrumental or voluntary responses.

The empirical concept of reinforcement applies only to operant behavior. It states that operant behavior is strengthened by certain consequent stimulus events. Some stimuli strengthen on presentation; some, on withdrawal. The only way to find out whether a stimulus is neutral (no strengthening value), positive (strengthens on presentation), or negative (strengthens on withdrawal) is by empirical test. Research along this line seeks not to "explain" reinforcement with organismic data or with intervening variables, but seeks to delineate the empirical relationships between reinforcing conditions and changes in operant strength.

Samples of research have been grouped into five categories. The first group is devoted to the development of a methodology; the second, to an analysis of the effects of schedules of reinforcing stimuli; the third, to a study of response functions; the fourth, to an investigation of some setting events; the fifth, to discriminative or perceptual stimuli. Some of the predominant characteristics of the work in this area have been pointed out. These include an emphasis on empirical theory building and a preference for laboratory analysis, individual control, and free operant methods.

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REINFORCEMENT IN DISCRIMINATION LEARNING: WITH SPECIAL ATTENTION TO THE EFFECTS OF DELAYED REINFORCEMENT*[1]

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A. INTRODUCTION

The concept of reinforcement has had enormous theoretical and practical significance in psychology. First will be presented a brief sketch of some of the uses to which the term *reinforcement* has been put in theoretical accounts of the learning process. This will be followed by a brief description of some of the research that involves children and in which the effects of different types of reinforcement on learning are shown. Finally, descriptions will be given of recent studies that involve the effects of reinforcement delay in discrimination learning. Throughout, this paper will place special emphasis on discrimination learning experiments.

Many learning theorists, particularly those of the so-called stimulus-response stripe, hold that learning requires the occurrence of both a motivating state (primary or secondary) and a reinforcement (19). The fact that some theorists do not agree with Hull (8) that *all* learning involves the law of effect (or the principal of reinforcement, as Hull prefers to call it) is unimportant for the purposes of this discussion. Although the concept of reinforcement initially was used in theoretical accounts of the learning of animals in trials and error and classical conditioning experiments, Spence (17, 18) has also made use of it in his theoretical papers on more complex discrimination learning. Spence conceives of discrimination learning as a cumulative process of building up the habit strength of the positive cue (e.g., the larger of two cube boxes in a two-stimulus size-discrimination task) as compared with the negative cue (the smaller cube box). The increase in the tendency to respond to the positive cue is presumed to be a result of the effects of consistent reinforcement to the positive cue and nonreinforcement to the negative cue. This process of differential reinforcement continues until the difference in habit strength between the positive and the negative cues is sufficiently great to offset any other differences in habit strengths "that may exist between the stimulus complexes of which the cues are members" (19). This theory has been shown to be useful in predicting the learning and transposition of animals and preverbal children in size discrimination problems (11, 18). For children who possess effective use of words, Kuenne has shown Spence's theory to be incomplete (11).

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[1] This paper, with some modification, was delivered at a symposium on reinforcement effects, Society for Research in Child Development, Pennsylvania State University, March 16, 1961.

Hilgard (6), Siegel and Foshee (16), to mention but a few, have urged more attempts, like Kuenne's, to ascertain the applicability at the human level of principles of learning that have been discovered appropriate at the infrahuman level. The law of primary reinforcement in Hull's system, that the strength of a habit is positively related to the frequency of reinforcement, has been supported at the animal level by Perin (13) and Williams (24). Siegel and Foshee (16), who used preschool children as *S*s, have shown that resistance to extinction of a lever-pressing response is a function of the number of reinforcements (small pellets of candy) that *S*s were given in the acquisition session. Recently, evidence has been presented that the principle of reinforcement does not operate in a simple S-R manner with older *S*s. In a multiple-choice learning situation, Stevenson and Weir (21) report that the effects of reinforcement and nonreinforcement differ as a function of chronological age. For three-year-old children, reinforcement increases the tendency for repetition of the reinforced response and nonreinforcement decreases this tendency. On the other hand, seven-year-old children tend "to change their response following reinforcement" almost as often as they do following nonreinforcement. Stevenson and Weir hold that, in multiple-choice learning situations, older children respond in terms of a "*pattern* of responses which lead to reinforcement," and suggest that reinforcement and nonreinforcement have identical effect on "*units* of response for older *S*s as they do on the *single* responses of younger *S*s" (21).

The concept of reinforcement is also important in research in child psychology for practical reasons. In learning research that involves children, the experimenter frequently is confronted with the problem of getting his *S*s to a criterion as quickly as possible in order that he may study the effects of certain other experimental manipulations. In other words, he may have no interest in reinforcement from a theoretical standpoint. The most effective reward under such conditions has been shown to be a function of a host of variables that, among others, include the nature and complexity of the task, the age and social-class membership of the *S*s, and the manner in which the reinforcement is administered. Many years ago Hurlock (9) found that elementary-school children solve arithmetic problems more effectively when praised than when reproved, ignored, or treated in a "work as usual" manner. Abel (1) found that nine- and ten-year-old children trained on a finger-maze problem under delayed-reward conditions make fewer errors than do those who are given praise, a penny, no reward at all, or a combination of these. Terrell and others (23) have found that middle-class kindergarten and elementary-school children learn a size discrimination problem more quickly when given a symbolic reinforcement (a light flash) than when given candy, while the reverse is true of lower class *S*s. Kuenne (11) found that preschool children require more than four times as many trials to learn a size discrimination task when given a toy reward than when given candy. Finally, Terrell (22) has presented evidence that the only reinforcement both preschool and elementary school children need in solving size and form problems derives from the explorations and manipulations involved in the task solution itself. Incidentally, it is the author's opinion that the type of reinforcement that comes from the child's own investigatory or manipulatory behavior is very significant in child behavior. Most normal preschool children initially can provide their own reinforcement in this manner. Undoubtedly, something about our child-rearing practices and our system of formal education does much to destroy this ability. We would do well to analyze systematically the variables that foster it.

I should like to turn my attention now to a discussion of my current research involving the effects of *delay* of reinforcement. Saltzman (15) was one of the first to demonstrate at the human level that the strength of a habit is in part a function of the temporal nearness of the reinforcement to the response. Lipsitt and Castaneda (12) showed that children develop preferences for and respond more quickly to a stimulus that has been associated with immediate reinforcement than to a stimulus with which a reinforcement delay has been associated. For the past year or more I have been exploring this problem within a discrimination learning setup at the University of Colorado. I should point out that this research is being supported by a grant from the National Institute of Mental Health.

Consistent with the findings of Lipsitt and Castaneda, children acquire discriminations more quickly when learning under an immediate- than under a delayed-reinforcement condition. What are the variables underlying the fact that for most children an immediate reward results in more efficient learning than a delayed reward? Incidentally, delayed reward *is* more effective for a few children, a fact that suggests interesting possibilities for research to reveal differences in conditions antecedent to such differences. A number of factors lead me to speculate that children who perform better under delayed reinforcement than under immediate reinforcement (*a*) have been rewarded for postponing pleasure, (*b*) have been encouraged to perseverate in learning situations that involve ambiguity and uncertainty, and (*c*) have derived more pleasure from the *activity* of learning than from some extrinsic, immediately delivered reinforcement.

A brief description will be given of the materials and procedures that are being used. For all experiments, five-and six-year-old children have served as *S*s. *S*s have learned two tasks (size and form) concurrently. One task is learned under an immediate reward; the other, under a seven-second delay. The reward is a light flash of one-second duration. The order of administering the task-reward combinations is counterbalanced. For all studies to be described here, two stimulus problems have been used.

B. Materials

All stimuli are three-dimensional geometric figures. The size task involves two cube boxes that have basal areas of two square inches and four square inches, respectively. The form problem involves a sphere that is three inches in diameter and a pyramid that is three inches in height, four inches on each side, and four inches on the base. Additional apparatus consists of a background board and a panel board. The background board is a 13-1/2″ × 13″ piece of plywood with two push-button mounts which are located two inches from the right and the left edges of the background board and 1-3/4″ from the front edge of the board. On each trial, the stimuli are placed onto the background board immediately in front of the push-button mounts. A piece of terry cloth is glued to the board where the stimuli are placed to keep the sphere from rolling out of position. Batteries and circuits to operate a signal light are concealed under the background board. Locked onto the rear edge of the background board is a 7-7/8″ × 10-3/4″ panel board that contains the signal light. This light is mounted in the center of the panel board, 1-1/8″ from the top. The circuits are so arranged that a correct response causes the light to go on. Two Hunter decade-type timers control the delay of reward and the one-second duration of the light flash.

C. Procedure and Results

The *S*s are tested individually. Each *S* receives the following instructions:

> This is a game where we play with these things (*E* shows the two cube boxes and the sphere and the pyramid to the *S*). Sometimes these two (*E* picks up the cube boxes) will be put here (*E* places the cube

> boxes on the background board immediately in front of the push buttons), and sometimes these two (*E* picks up the sphere and the pyramid) will be put here (*E* places the sphere and the pyramid on the background board). Your are supposed to choose one of these (*E* again points to the cube boxes and the sphere and the pyramid) and push the button (*E* points to the push buttons) in front of the one you choose. If you are right, that light will go on (*E* points to the light on the panel board). If you are wrong, the light will not go on. Now remember, the game is to see how soon you can make the light go on every time.

The last sentence is repeated after the fifth trial in a further effort to insure that the *S*s understand the point of the task. Training is continued until *S*s are correct on six consecutive trials.

As indicated, *S*s learn significantly faster under the immediate-reinforcement condition. On the basis of a suggestion made by Spence (20) and on recent instrumental learning research by Rieber (14), it might be assumed that there would be more competing responses present when *S*s are learning under the delayed-reinforcement condition than under the immediate-reinforcement condition. This would lead to a prediction that *S*s would take *more* time to decide which of the stimulus objects to choose when learning under the delayed- than when under the immediate-reinforcement condition. It is believed that, in a discrimination learning study, the time interval between the presentation of a stimulus complex and the onset of *S*'s response (the decision time) can be conceived of as an index of the strength of the appropriate association between stimulus and response components in the learning situation.

Hulicka (7) employed a similar definition of the associative variable. Also, in an experiment that requires *S*s to depress a response button, it is believed that the speed with which they push the button can be conceived of as an index of *S*s' incentive to perform the task. By use of these two latencies, the relative effects of immediate and delayed reinforcement on associative and incentive factors were then investigated.

To obtain measures of strength of association and incentive, Standard electric and Hunter electronic timers were added to the basic apparatus. Mounted under the front edge of the background board was a wooden bar containing a slot which housed a microswitch and a 13.5″ × 13″ plywood shield. The Standard and the Hunter timers measured reaction time to .01 and .001 of a second, respectively. The circuits were so arranged that removal of the shield activated the microswitch, which in turn activated the Standard timer. Depression of either of the push buttons to the extent of one millimeter broke the circuit to the Standard timer and simultaneously activated the Hunter timer. The Hunter timer was deactivated when the stem of the push button was depressed its full distance by *S*. Measurements of associative and of incentive latencies were obtained on the Standard and the Hunter timers, respectively.

Twenty *S*s were then administered the size and the form discrimination problems in the manner described above.

The Wilcoxon matched-pairs signed-ranks test was used to analyze both latency measures. The effects of the reinforcement conditions on both measures were determined at three points in the learning process: (*a*) the first six trials, (*b*) the point at which *S* reached criterion on the *first* of the two tasks (the six adjusted trials),[2] and (*c*) the six criterion trials. For both of the latency measures a raw score for each *S* for each of the two reinforcement categories was determined by summing the latencies of six trials at the three points in the learning process. The associative latencies, with the exception of the first-six-trials analysis, were significantly shorter under the delayed- than under the immediate-reinforcement condition ($p = .44$, .003, and .02 for the first six trials, adjusted trials, and criterion trials respectively). The reinforcement conditions did not affect differentially the incentive latencies ($p = .50$, .35, and .62 for the first six trials, adjusted trials, and criterion trials, respectively). It is believed that, due to the shortness of the push-button stems, the incentive measure was not sensitive enough to pick up differences (if any) in the effect of the treatment conditions.

D. Discussion

Contrary to Spence's hypothesis and the results of the Rieber study, *S*s responded more quickly to the task with which *delay* of reinforcement was associated (even though they learned this task less quickly) than they responded to the task with which immediate-reinforcement was associated. This difference can be explained in terms of the difference in requirements of the tasks in the two experiments. Rieber's *S*s were required to depress a lever when the conditioned stimulus, a light flash, appeared. In return, they received a trinket. In the present study, *S*s were required to *make a decision* as to which of two stimulus objects to choose and then were to push a button in front of the chosen stimulus.

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[2] Adjusted scores were determined by the number of trials to the first criterion and the reinforcement condition under which *S*s first reached criterion. For example, if *S* required 10 trials (exclusive of the six criterial trials) under the immediate-condition and 18 trials (exclusive of the six criterial trials) under the delayed-reinforcement condition to learn the correct response, the sum of the six criterial trials (trials 11-16, inclusive) under the immediate condition was compared with the sum of trials 11-16, inclusive, under the delayed-reinforcement condition. If *S*s reached criterion first under the delayed-reinforcement condition, measurements under the immediate condition were adjusted. This adjustment was made for each *S*.

It is believed that the inconsistency in the results of the two experiments does not refute the response-competition hypothesis. The effects of the competition in the two studies are simply different. In the simpler Rieber instrumental learning setup, the greater incidence of competing responses under the delayed condition apparently serves to *hold back* the impetus to action by *S*, while in the more difficult discrimination learning situation, *S*s are quite conceivably more upset by the competing responses than were the Rieber *S*s.

At both the human and the infrahuman level, studies have shown that frustration impairs performance on relatively complex tasks and is associated with an increased muscular tension that produces faster reactions (2, 3, 4, 5, 10). It seems reasonable to suggest that, in the present experiment, *S*s were thwarted because of the delay of an indication of the correctness or the incorrectness of their response, and that they reacted in an impulsive, nonreflective way; gave little attention, if any, to the significant elements of the task; and made ineffective use of previous experience with the task. When reinforcement follows correct responses immediately, most *S*s apparently are more attentive to the meaningful components of the task situation, a fact that leads to a quicker strengthening of the correct habits. Research designed to test this hypothesis is now in progress.

E. New Study

For a measure of frustration, the galvanic skin response has been selected. If my reasoning is valid, *S*s should exhibit higher GSRs when learning under the delayed-reinforcement than under an immediate-reinforcement condition. The same procedures as employed in the preceding study are being used. A polygraph manufactured by the Grass Instrument Company is being used. This instrument has three channels in addition to the one that records GSR changes, a fact which makes it possible for us to analyze GSR changes at different stages of each trial. One channel indicates when the trial begins (i.e., when *E* lifts the shield); another channel marks the moment when *S* touches the response button; the third channel indicates when the light goes on.

In addition to the GSR measures, I am getting three behavioral measures: (*a*) *S*'s attention to the task, (*b*) the relevance of *S*'s verbalizations to the task, and (*c*) the nature of *S*'s attitudes toward the tasks as revealed by his comments. The prediction is that *S*s will attend to the task more consistently, will make more comments that are relevant to the task itself, and will make more statements that indicate favorable attitudes toward the tasks when learning under the immediate- rather than when learning under the delayed-treatment condition.

1. *Procedure*

Two trained observers are seated in a position from which they can see *S*. Observers record each instance when *S*'s visual orientation is toward any object other than the stimuli of the task, the apparatus, or *E*. All verbalizations of the *S* are rated on a three-point scale along two dimensions: *relevance to the task* and *attitude toward the task*. For the relevance dimension, *O* assigns a score of 3, 2, or 1 for "Irrelevant," "Neutral," and "Relevant" judgments, respectively. For the attitude variable, a score of 3, 2, or 1 is assigned for "Negative," "Neutral," or "Positive" judgments, respectively.

2. *Preliminary Results*

A preliminary study with college students has been completed. This study has indicated a high level of agreement between observers. Interestingly enough, although college students learn the tasks in about one-half the number of trials required by children, with respect to *both* children and college students, the "Immediate" task is learned in about one-third of the trials required in the "Delayed" problem. Although no analyses have been made of the data on these *S*s, an inspection of the GSR data suggests sharp differences in the predicted direction. Only three of 13 *S*s present higher GSRs under the immediate-reinforcement condition. Work is just getting under way with the experiment with children.

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THE EFFECT OF SOCIAL REINFORCEMENT ON NORMAL AND SOCIALLY DEPRIVED CHILDREN*[1][2]

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Several years ago, Harold Stevenson and I became interested in the behavioral differences manifested by normal and retarded children of the same mental age (15). Our experimental findings led us to reject the Lewin-Kounin formulation that retardates are inherently more rigid than normals (7, 8). After analyzing the tasks employed by Lewin and Kounin, we advanced the view that the reported differences in performance were related to differences in the children's motivation to interact with an adult and to their motivation to maintain interaction by complying with instructions rather than to differences in cognitive rigidity.

Our hypothesis was based on the assumption that institutionalized retardates tend to have been deprived of adult contact and approval and hence have a higher motivation to procure such contact and approval than do normal children. Stated differently, the position was advanced that social reinforcers are more reinforcing for the responses of retarded children than they are for normal children, and that this phenomenon is due to the deprivation experienced by institutionalized children on this particular class of reinforcers. So stated, this position can be recognized as one that lies at the heart of one of psychology's oldest and warmest controversies. The question of whether social deprivation results in a heightening, a lessening, or no change in the efficacy of social reinforcers has long been disputed.

The position stated above was tested in a study that employed the following general hypothesis:

> The greater the amount of social deprivation experienced by the feebleminded child, the greater will be his motivation to interact with an adult, making such interaction and any adult approval or support that accompanies it more reinforcing for his responses than for the re-

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[2] This paper, with some modification, was delivered at a symposium on reinforcement effects, Society for Research in Child Development, Pennsylvania State University, March 16, 1961.

> sponses of a feebleminded child who has experienced a lesser amount of social deprivation.

I would like to focus the remainder of my discussion not on the outcome of this study but upon the methodological and theoretical difficulties presented by the hypothesis just stated, with special attention to the problem of defining social deprivation. It is my conviction that the present controversy on the effects of social deprivation and on the related problem of the subsequent efficacy of social reinforcers is, in large part, due to the failure of many investigators to appreciate the methodological and theoretical issues inherent in hypotheses that are presented with a facade of simplicity.

In dealing with the previously stated hypothesis, I came to grips with the problem of defining social deprivation. A review of the literature revealed no concise, accepted definition of social deprivation. As other investigators have done, I concluded that this concept has been loosely applied to certain events in early childhood which in turn are characterized as being antecedent to certain social behaviors. The problem is that there is little agreement on either the early events or on the resultant behaviors. How, then, does one cleanly handle the social deprivation variable?

In my enthusiasm for scientific rigor, I became enamored over the possibilities in Gewirtz and Baer's approach to this problem (5, 6). As may be recalled, Gewirtz and Baer avoided looseness in definition by implementing social deprivation so that a brief period of social isolation was equated to a condition of deprivation of all social reinforcers. They thus reduced deprivation to the short-term operation often employed in general behavior theory in which deprivation means "the unavailability to an organism of a given reinforcer for a period sufficient to effect an increase in behaviors for it."

Upon further reflection, I concluded that Gewirtz and Baer's approach was not appropriate for my purposes. Of course, I could have subjected half of my institutionalized feebleminded subjects to a 20-minute isolation period —the remaining subjects not being placed in such a condition—and then predicted that I would get differences between the two groups on some dependent variable. However, I think that it is an error to believe that any set of operations, regardless of how explicit, magically yields the same results with all types of subjects.

In fact, my theorizing led me to conclude that such a 20-minute isolation period would not effectively alter the performance of institutionalized feebleminded children. If, as I have assumed, these children come to the experimental setting with a considerable amount of social deprivation, one would not expect 20 minutes of isolation to add significantly to the high effectiveness of a social reinforcer. Furthermore, it appears to me that the extent to which a particular set of environmental conditions is socially depriving in nature depends on how such a set of conditions is experienced by the child.

Let me say that this concern need not lead us into a phenomenological morass. The manner in which a child will experience any particular environmental configuration can in part be objectively assessed by gauging the experiential history of the child prior to his encounter with this particular situation. On a purely objective level, one can assert that the Gewirtz-Baer operation will not be experienced as socially depriving situation by institutionalized children who often experience arbitrary periods of waiting, adult inattention, etc.

This point becomes an especially pertinent one in view of the recent criticism by Walters and Ray (12) that the Gewirtz-Baer isolation period raises the anxiety experienced by the subject, but has little to do with a social deprivation concept. While I welcome the raising, by Walters, of the anxiety issue, I disagree that awareness of the anxiety factor vitiates the need for a social deprivation concept. Again, I must assert that an individual's encounter with a particular set of environmental events—be these events objectively classified as socially-depriving or be they of any other variety—does not in itself induce behavior, for these events are external to the organism. Before any prediction can be made on the result of such an encounter, some attention must be given to the internal state that is aroused as a result of the encounter. It is the internal state that is the mediating mechanism between the situational configuration and the subsequent behavior of the individual.

It seems plausible that once certain objective social reinforcers become effective, and are thus desired by the individual, their absence or withdrawal should result in the individual's experiencing a state of anxiety. It is this state of anxiety that motivates the individual in subsequent situations to perform certain responses that lead to the reduction of this annoying state. However, the postulation of an anxiety state does not negate the exploratory value of a social deprivation concept. It is apparent that a multitude of conditions give rise to general anxiety states, while an equal or greater number of responses are employed by individuals to reduce such states.

If adequately defined, the value of a social deprivation concept lies in its specificity. It suggests that class of events which gives rise to this internal state and, more importantly, it should suggest the particular class of behaviors that the individual will emit in defined situations. Thus a person who has come to value money will become anxious when he finds himself jobless, and one would predict that such a person would become more responsive to that class of reinforcers whose receipt would allay the anxiety. However, one would not expect him to become more responsive to all reinforcers in an indiscriminate manner. Analogously, the value of the social deprivation concept lies in the specification of a particular class of reinforcers towards which the socially deprived individual will display an increased responsivity.

The reasoning inherent in the foregoing discussion led me to the view that Gewirtz and Baer's manipulation was not appropriate for an adequate test of the hypothesis advanced. This view received further confirmation from Gewirtz's earlier statement (4) that such a short-term contemporaneous model is not the appropriate one when dealing with the concept of deprivation, as employed by such investigators as Spitz, Ribble, Goldfarb and Levy. To these investigators, "deprivation" means long-time deficits; hence an appropriate definition of deprivation must reflect conditions that operate through wide segments of time. In dealing with the type of social deprivation experienced by feebleminded children, we require a measure that will reflect long-term deficits, thus making the short-term drive operation of Gewirtz and Baer inappropriate.

After rejecting the Gewirtz-Baer manipulation, I entertained the possibility of using length of institutionalization as a measure of social deprivation. Such a measure would meet the requirement of reflecting conditions operative through relatively wide segments of time. In addition, this measure has whatever advantage lies in being, perhaps, the most widely used referrent of social deprivation. However, upon closer analysis, I came to the conclusion that institutionalization *qua* institutionalization is not a clear measure of social deprivation. There can be little doubt that the contemporary conditions of institutionalization must be a determinant of the child's current behavior. However, the results of such institutionalization are far from clear. A fact that has been rarely recognized is that institutionalization is not in itself a psychological variable. At best it refers to a vague social status of the individual. In order to relate institutionalization to social deprivation, one must designate specific social interactions in the institution that give rise to particular behavioral propensities.

Anyone who treats institutionalization as a homogeneous entity must be prepared to defend the proposition that critical social interactions are constant from institution to institution. But how can such a defense be made when there has been no systematic effort to discuss the psychological features, if any, that are common to all institutions. I concur with Sarason and Gladwin (9) in their amazement that so little systematic work has been done in the investigation of the nature of institutionalization. While I have certain misgivings concerning René Spitz's work (10), his report of striking differences between children in two institutions is pertinent here.

Why, one might ask, have fairly constant findings been reported when institutionalized children are compared with noninstitutionalized children? What is the common feature of institutions that gives rise to the findings? The answer may be that there is some highly significant factor that as yet is unspecified. If such is the case, then the foregoing discussion may be considered an appeal for cross-institutional investigation conducted for the purpose of isolating this factor. However, another possibility may be considered. Perhaps the commonality in the findings of studies in which institutionalization is employed as a variable is due not to a common feature of institutions, but instead to the fact that children who are institutionalized come from homes that present a common and relatively homogeneous psychological environment. The latter possibility suggests that it is the preinstitutional social deprivation experienced by the child that needs evaluation. Institutionalization should be analyzed for its particular psychological features and for its effects viewed as interacting with the effects of the preinstitutional psychological environment. Thus one and the same institution would be viewed as having different effects on children whose preinstitutional histories differed. This view is supported by Clarke and Clarke's finding (2) that institutionalized feebleminded children who come from impoverished social backgrounds show an increase in mental test scores, while children from relatively good homes do not.

Although the decision was made that social deprivation should reflect the preinstitutional history of the child, the question of definition was not solved. Since we would like the social deprivation variable to reflect certain events in the individual's history, we could designate such events and then define social deprivation in terms of the occurrence or nonoccurrence of these events in an individual's history. However, since the population of events that constitutes social deprivation has never been adequately delimited, such a procedure would be arbitrary at best. The procedure finally employed was that of asking judges to evaluate the entire preinstitutional social history of the child for social deprivation while, at the same time, noting the specific factors in the history which determined the evaluation (14). The only instructions the raters were given was that social deprivation referred to the nature of the interactions that the child had had with the important adults in his life.

I am pleased to report that this procedure resulted not only in reliable ratings, but also in the extraction of a universe of relatively objective factors that now constitute the major portion of a recently constructed social deprivation scale. Included in this scale are such items as the economic circumstances of the home, the physical treatment accorded the child, the familial configuration, the parents' adherence to social norms, the attitude of the parents towards the child, and the general adjustment of the child. These items are not surprising as measures of social deprivation. However, they possess an advantage not shared with numerous others that have been used as referents of social deprivation. The items were not included in the scale on *a priori* grounds; they were included only after an empirical relationship between the items and the effectiveness of commonly dispensed reinforcers had been demonstrated.

Time does not permit a close analysis of the other problems raised by my hypothesis, but I would like to mention them briefly in order to note the complications that they present. One of these problems is the lack of specificity concerning the reinforcer. Interaction with an adult and adult approval and support encompass at least three different classes of reinforcers: (*a*) attention, (*b*) support, and (*c*) environmental change. Evidence indicates that all three of these classes of reinforcers are capable of acting independently as generalized reinforcers; therefore it becomes a matter of considerable import to designate what specific reinforcers are thought to be operating in the experimental conditions employed to test the hypothesis. This problem opens Pandora's box.

It is my conviction that a psychology of human behavior will make little headway so long as it persists in grouping all reinforcers together and conceptualizing them as pellets. I have been impressed by the efforts of Bijou and Sturges (1), Terrell (11), and Witryol (13) in investigating this problem.

Two obvious errors continue to plague us. The first appears to be a product of the experimenter's egocentricity, a product that manifests itself in the continued belief that the only reinforcer that operates in an experimental situation is the reinforcer that the experimenter consciously deigns to introduce or to manipulate. The second error is our failure to appreciate fully the existence of developmentally changing reinforcer-hierarchies and the existence of idiosyncratic reinforcer-hierarchies within any developmental level. It is my view that the differing effectiveness of a reinforcer across children, in conjunction with the question of the particular environmental histories that give rise to such differences, is the most underinvestigated as well as the most exciting area in child development.

The final difficulty that I should like to mention with the hypothesis stated originally is the designation of the specific response that is thought to be reinforced. It has been shown that social reinforcers are general in nature and that their availability influences the occurrence of certain behaviors while not affecting others. Added to this difficulty are certain of my own recent findings that the particular response that is affected by the reinforcer varies across children as a function of their particular environmental histories, a possibility that Gewirtz (3) noted several years ago.

Again, our own egocentricity has often blinded us to the possibility that social reinforcers affect a response other than the one we decide to use as a dependent variable. If *E* employs social reinforcers while a child is performing on a simple, two-hole marble game, what is the appropriate dependent variable? Is it the percentage of responses to the reinforced hole, the rate of insertions, the length of time the child will play, or the quantity and character of the comments that the child makes during the game? The answer is that all alternatives must be investigated and that differences among children must be carefully analyzed before any comprehensive understanding of the reinforcement process can emerge.

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REINFORCEMENT AND PERSONALITY DEVELOPMENT IN CHILDREN*[1]

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A. INTRODUCTION

The central purpose of the present paper is to stress the relevance to the topic of this symposium of the psychoanalytic proposition regarding the multidetermination of behavior, and to attempt to indicate some of the implications of this deceptively simple proposition for research on variables such as reinforcement.

B. MODEL

As it occurs in dynamic theories of personality development, the multidetermination thesis states that some if not all behavior is based upon a multiplicity of determinants that, in some instances, include mediating dynamic personality variables in interaction with environmental variables in a temporal (ontogenetic) context. If this proposition is valid, there is need for a comprehensive conceptual model that suggests the full range of potential sources of variance in behavior. One of the simplest and best known of such schemes, and the one to be used in the following discussion, is that which divides behavior conceptually into three classes. First, there are behaviors that are entirely a function of variables in the environment; the shorthand for this statement is $B = f(E)$. Second, there are behaviors that are entirely a function of variables within the child; the shorthand for this statement is $B = f(P)$. Third, there are behaviors that are a function of variables within the child in interaction with variables within the environment; the shorthand for this statement is $B = f(E, P)$.[2]

Following Rapaport (10), upon whose theoretical work this discussion leans heavily, the terms of the functions named above are defined as follows. The term B consists of three main classes of variables: affective variables,

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[1] This paper, with some modification, was delivered at a symposium on reinforcement effects, Society for Research in Child Development, Pennsylvania State University, March 16, 1961.

[2] Many workers, including Lewin (9) and Rapaport (10), have utilized schemes of this type.

cognitive variables, and action (e.g., motor) variables. The term P consists of two main classes of variables: motivations, and structures such as unconscious defenses and other enduring control and delay mechanisms. Finally, the term E consists of all the variables that constitute external reality. Many of our typical reinforcement variables are encompassed by this term.

Before proceeding to a detailed look at each of our three functions, two important characteristics of the elements of the terms B, E, and P should be specified. First, these elements or variables may appear or be effective at various levels of consciousness: Some determinants may be noticeable to the child and always noticed. Others may be noticeable but not always noticed. Still others may be unnoticeable. Second, all the terms and the matrix of variables for which they stand have a history; this implies the need for an ontogenetic or developmental point of view.

1. *B as a Function of E*

Certain behavior (responses) seem best described by the $B = f(E)$ function. Here, the environment is said to be compelling in the sense that changes in certain of its elements result in changes in a particular response. Such responses may be either directly related in a one-to-one fashion to a particular element (stimulus) in the environment, or they may be determined by more than one element in the context. Furthermore, in research designs in which the experimenter manipulates some aspect of the environment and measures some specific response, other relevant variables or elements of the environment and/or behavior *may* enter the system as intervening variables.[3]

Behavior that approaches the function under discussion includes reflexive behavior, unconditioned responses in the classical conditioning paradigm, perhaps certain well-established conditioned and instrumental responses, and the behavior referred to by Hartmann as "conflict free." Basic reflexive and unconditioned response types of behavior, such as the knee-jerk response to a tap on the patellar tendon and the withdrawal of fingers from contact with a hot oven, are illustrative of $B = f(E)$. The concept of reinforcement, however, is more useful in explaining unconditioned responses than in explaining reflexes. The connection of the unconditioned stimulus with the unconditioned response through the latter's primary reinforcing or adaptive properties is an example of one of the effects of reinforcement on behaviors of the $B = f(E)$ type.

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[3] In the present paper we adhere to the *mathematical* conception of independent-intervening-dependent variables in general use in scientific methodology and as outlined by Koch (8).

Conditioned responses and instrumental responses, on the other hand, are probably only borderline examples of this function-form in view of fluctuations and individual differences in learning speed, in resistance to extinction, and in qualitative differences in responses that seem to be related to or mediated by intrapersonal variables (e.g., drives and defenses).

Responses of the "conflict-free" type are thought to occur more or less automatically without being significantly modified by variables within the person. They are thought to include certain motor, perceptual, and language patterns, some of which come built into the organism at birth (primary autonomy) and some of which were at one time mediated by internal variables, but subsequently became relatively autonomous (secondary autonomy).

Experimental psychologists have tended to study—or generally have intended to study—behavior as a function of the environment. This approach minimizes the presence of (*a*) stable individual differences in such responses, and (*b*) intrapersonal (motivational, structural) variables mediating the stimulus and the response.

2. *B as a Function of P*

Some behavior seems best described by the $B = f(P)$ function. In Rapaport's words (10), this behavior is behavior "in which the role of reality . . . [is] . . . negligible, and the role of the person's drives and defenses [are] paramount, in determining behavior." Rapaport also states that such behavior is "peremptory and overvalent, tolerating neither delay nor detour, as though it were striving for immediate discharge of a great quantity of excitation." As is the case with $B = f(E)$, behaviors of the $B = f(P)$ type are of the immediate tension or drive reduction type; that is, they also tend to have primary reinforcement characteristics. Impulsive aggressive actions, hallucinatory behavior, and autistic gestures are examples of behaviors in which the role of immediate external reality can be negligible.

Such behavior may be either directly related in a one-to-one fashion to a particular element (stimulus) within the child, or it may be a function of more than one intrapersonal element. In addition, in research designs in which the experimenter manipulates some variable within the child (e.g., dependency needs) and measures some specific response (e.g., anxiety level, inkblot response, or motor activity), all other intrapersonal variables (i.e., other motivations, structures) or behavioral variables (i.e., other actions, affects, cognitions) may enter the system as intervening variables.

Clinicians and personality researchers have tended to study—or generally have intended to study—behavior as a function of variables within the person. This approach emphasizes the presence of stable individual differences in such variables and it minimizes the role of environmental variables mediating the stimulus and the response.

3. *B as a Function of (E, P)*

It seems clear that the range of human behavior that can be described validly by either $B = f(E)$ or $B = f(P)$ is quite narrow. Even when these functions do not imply a one-to-one relation between stimulus and response and between drive and behavior, they fail to account for complex behaviors in which there is simultaneous operation of motivational and structural variables, and affective, ideational, and action systems of behavior in a multivariate context. Such behaviors are always of the $B = f(E, P)$ variety. Much of the unexplained variance in the results of many of our studies is presumably due to such variables. It seems likely that many of the dependent variables that are frequently seen as a function of independent variables in the environment, such as amount of reinforcement, partial reinforcement, delay of reinforcement, and so on, fall into this category.

For example, suppose we establish a hypothetical experiment in which magnitude of incentive is the independent variable and rate of some motor response is the dependent variable. The experiment apparently is rigorously controlled, and our measures seem to be tight and clean. Analysis of the results reveals a significant relation between our independent and dependent variables. Another researcher replicates our hypothetical study, using an identical design, identical apparatus, and identical measures, but finds no reliable relation between the same independent and dependent variables. Although this example is hypothetical, such paradoxes can and do occur. They may be less puzzling, however, when considered in a broader theoretical framework. Even such relatively simple variables as rate of response presumably are a function of many interacting behavioral, intrapersonal, and environmental variables (e.g., anxiety level, defensiveness, sex of child, sex of the experimenter). Achievement of consistent replicability and continued positive findings in many research areas may depend on how perceptive and creative we are in taking such variables into account in designing our research. Inclusion of variables such as level of anxiety in our research designs may seem to "dirty" our studies because measures of these variables are frequently not as precise as some of the typical laboratory variables. However, in the long run we may find that systematic introduction of relevant dynamic variables into our experiments will result in greater replicability and in broader validity.

Each of the terms of the funcion $B = f(E, P)$ is multivariate in structure. One of the consequences of the fact that each of these terms is a matrix of potentially effective variables, many of which may be simultaneously operative, is that the child may respond in the same way to many different stimulus elements (overdetermination) or he may make many different responses to the same stimulus. Frenkel-Brunswik's report (5) "Motivation and Behavior" is cited by Rapaport (10) to indicate how this is true of motivation. Frenkel-Brunswik's study showed that a particular drive may be manifested in many different correlated and uncorrelated overt behaviors or satisfied by many objects; and, conversely, that many different motives may find manifestation in the same object.

Any of the variables of which B, E, and P are composed may show up in our research studies as independent, dependent, or intervening variables (10). Thus, any kind of behavior, including cognition and affect as well as observable actions, *may* appear in any of these roles. Similarly, the motivations and defensive, controlling, and delaying structures within the child, and a myriad of variables in the social and physical environment, *may* appear as independent, dependent, or intervening variables.

C. B AS A FUNCTION OF (E, P) IN AN ONTOGENETIC FRAMEWORK

Thus far in the paper, emphasis has been on the point of view that there are conceptual and methodological advantages to a systematic consideration of the complexity of behavior in the design and execution of experimental research. It seems equally important, however, that we also systematically consider the developmental or ontogenetic dimension of $B = f(E, P)$. Attention to this dimension requires consideration of such factors as the role of early experience, constitutional givens, and previous learning experiences. Ontogenetic models, such as the one formulated by Erikson (4), treat behavior as an epigenetic product that must be studied developmentally if it is to be fully explained. In other words, the present personality organization, considered in the broadest sense, can be understood only through investigation of the antecedents of the organization. The antecedents include the interactions over time between "inborn givens" and environmental factors as well as reformation and differentiation of preceding patterns. It follows that full understanding of a particular behavior requires a knowledge of the history of the motivations, structures, cognitions, affects, and actions in interaction with each other and with the social and physical environment experienced by the individual.

The usefulness of a combined ontogenetic and dynamic framework lies in the increased predictive power it promises in the interpretation of behaviors that appear identical, but which subsequently prove to have different roots and different consequents. For example, two identical intelligence test scores or mental age scores obtained in identical interviews with the same clinician may reflect significantly different intellectual potential when interpreted against a background of previous experiences and the drives, defenses, affects, and imageries that mediate the test stimuli and the child's responses. This is one of the reasons that clinicians generally have favored such a framework in the development and application of methods of differential diagnosis.

From a research point of view, an ontogenetic-dynamic model can be useful in suggesting which of the many, potentially effective dynamic variables may be most effective at any given level of development. To illustrate, suppose we are interested in designing a study of the effects of social reinforcement on operant learning behavior in infants from six to 10 months old. If we work within an ontogenetic-dynamic framework, it seems more likely that we will be alert to the importance of "stranger anxiety" in infants of this age, and more likely to control for the effects of this variable in our design. In some instances, such an approach may result in the design of a tighter and/or more meaningful study. For example, in operant-conditioning studies of infants, such a model might lead us to incorporate within the research design a study of the relative effectiveness of mothers and of "strange" experimenters as social reinforcers of the operant learning behavior of infants who manifest stranger-anxiety and of infants who do not manifest such anxiety.

An ontogenetic-dynamic framework seems especially relevant and useful for experimental studies that use nursery school children as *S*s, in that it sensitizes us to emotional and social variables that are particularly prominent determinants of the behavior of preschool children (e.g., dependency-autonomy needs, oedipal conflicts, and sex-role identification) and that may strongly influence experimental results. There is increasing evidence that such factors interact with variables such as task content, type of reinforcement, and sex of the experimenter. See Stevenson (13).

D. SUMMARY OF RESEARCH IMPLICATIONS

A recently published study reported no reliable difference between the reinforcing effects of one small Spanish peanut in contrast to four such peanuts during the learning of a discrimination problem. In the same study, "unexpected" differences in experimenter behavior were discovered to affect children's learning significantly. The presence of numerous examples in the research literature suggests that, in our experimental designs, it may be time for us to admit determinants such as characteristics of the examiner to a place more commensurate with their relative contribution to behavior variability. It is becoming increasingly clear that we will eventually need to come to terms with a wide range of relatively neglected variables if we are ever to approach a full explanation of child behavior.

In any situation in which research is conducted with children, there are a great many variables that are operative (i.e., that contribute to variance in behavior). These include cognitive, affective, and motor behavior; motivations; defensive, controlling, and delaying structures within the child; a matrix of social and physical variables in the environment; and genetic factors and physiological differences in the nervous system. It seems obvious that we cannot control or systematically account for *all* of these variables in the design and execution of each research study. We can, however, strive toward the goal of designing studies that systematically account for those variables that are potentially most relevant to the study of particular experimenal variables. One of the implications of the present discussion is that achievement of this goal can be facilitated by serious study of dynamic epigenetic theories of behavior that attempt to specify the sources of variance in a very comprehensive way.

Ignoring major sources of variance in research situations or always counting upon them to be random is, perhaps, only an evasion of conceptual and methodological problems with which we will eventually have to come to terms if we are to have a comprehensive and valid science of behavior. Furthermore, it is only by attempting to come to grips with these conceptual and methodological problems in their full complexity that we are likely to develop the new methods and designs that are admittedly needed. This calls for increased use of the team approach which has proven effective and productive in many research settings. Many studies of the future may profitably utilize a combination of clinical and experimental methods in the area of child development. For example, experimentalists and clinicians might collaborate in controlling and/or varying intrapersonal variables through intensive personality studies that utilize clinical interviews, projective tests, play therapy, and so on, while at the same time manipulating and measuring some of the traditional learning variables. The promising new techniques being developed for studying neonates, infants, and mothers, by such workers as Bell (1), Brody (3), Kessen, Hendry, and Lentzondorff (7), and Rheingold (11) are illustrative of how new methodology follows or grows out of the attempt to take a more comprehensive view of child development.

As mentioned earlier, failure to pay sufficient attention to the possibility of multideterminants of behavior may be one of the roots of our replication difficulties. Failure to replicate the results of a given study may occur because one or more subordinate variables in the original setting assumes the dominant role in a different setting and/or at a different point in time. Failure to consider this possibility may lead to a false interpretation of the results of both the original study and the replication, in that the failure to replicate the results may lead to an unjust rejection of the results of the original study as well as to a misinterpretation of the results of the replication.

If there are some kinds of behavior in which no one specific determinant is inevitably the dominant causal variable, then it does not make sense to ignore or neglect subordinate determinants of these behaviors—even when we are primarily concerned with the effects of one particular dominant determiner. We are probably less likely to commit this error if we attempt to determine in advance which of our functions is most appropriate for the behavior under study. Presumably most if not all significant psychological behavior is overdetermined, but some behaviors may be best studied as $B = f(E)$ or $B = f(P)$. Some behaviors have many intervening variables between S and R, and others have few. Certainly such variables as amount of reinforcement will operate differently depending upon which of the three functions is most applicable for a particular dependent variable. Specifically, we need to pay more attention to the role of defensive, controlling, and regulating intrapersonal structures in our research. These are the kinds of variables that eventually may be viewed as the "information engineering network" that controls the "power engineering network" of child behavior. Second, we need to divide E into components that may mediate the effects of independent variables. This should lead to a systematic specification and study of many narrowly defined "expectable environments."

In addition, we should always consider the level of epigenetic development of our *S*s. Only comprehensive research at all levels of development will provide answers to such questions as the following: Are there stages or hierarchical levels of organization of behavior related to time and, if so, what causes the transitions from level to level? In particular, what is the role of reinforcement in these transitions? Does this role vary with other aspects of personality structure and development and changes in the environment? There is also a dearth of comprehensive human studies bearing upon the history of reinforcement effects in single cases. Probing, intensive clinical-experimental studies such as the Scheerer, Rothman, and Goldstein study of an idiot savant (12) would seem to shed considerable light upon reinforcement effects.

The problem of manipulability is bound to be raised, in that although the variables of each of the terms in our $B = f(E, P)$ function can be treated logically as independent, intervening, and dependent variables, they are not equally easy to manipulate or to measure. In fact, as Rapaport points out (10), some of the variables are not amenable to *direct* manipulation. In addition, many kinds of manipulation of intrapersonal and environmental variables are possible but not ethical in the study of children. We cannot take the same liberties with children that we sometimes take with animals, but we can and should make better use of individual case studies, survey methods, and natural experiments. The latter is a type of experimental research that is especially loaded with untapped, potentially rich, research ore. For example, there are underway several studies that utilize pregnancy as a natural experimental manipulation (2). In such studies, personality structures and motivations may appear as dependent variables, and aspects of external reality may appear as intervening variables (e.g., husband's attitudes and reactions, prenatal educational experiences, etc.). Information about such dependent variables could then be used to improve research studies of mother-child interactions. For example, in the Brody study of patterns of mothering (3), there was no way of assigning mothers to particular groups in advance, but if we studied the mothers during their pregnancy we could then assign them to groups in advance so that (*a*) the personality patterns of mothers could serve as the independent variable, (*b*) their behavior could serve as the dependent variable, and (*c*) external reality could serve as the intervening variable, and so on. This shows how systematic variation could be more efficient than replication.

In conclusion, the main point of this paper has been that in focusing exclusively upon one independent variable, such as number of crackerjack toys it takes to increase the probability of occurrence of a response such as button pushing, we may overlook dynamic variables in the personality of the child or overlook significant aspects of the situation that may account for much of the unexplained variance in our results. The personality organization of the child in interaction with many possible social and physical elements of the experimental situation at a specific point in time determines or defines the limits or the effects of reinforcement upon behavior.

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REMARKS ON PAPERS PRESENTED DURING SYMPOSIUM ON REINFORCEMENT EFFECTS * [1]

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In reviewing the papers presented, I am struck by the fact that, with the possible exception of Professor Bijou's paper, they seem not so much discussions of reinforcement effects as they seem flights from reinforcement. After having noted (*a*) that there are test operations for the determination of gross reinforcement effect or (*b*) that there are systematic changes in the probability of occurrence of some response preceding the reinforcement operation, and (*c*) that the fact of reinforcement remains unadorned and unassailable, each of the symposiasts has hurried on to talk about something else. For so few statements, the range is wide and the variety is great. Professor Bijou moves from his solid base on the empirical laws of reinforcement scheduling to speak of the setting operations of deprivation and satiation and the importance of chained behavior. Professor Terrell goes further. He speaks of patterns of response, of the child's pleasure from the activity of learning, and of the apparent importance of the child's attitudes and verbalizations. We are nearly in full flight when Professor Zigler speaks of internal states of receptivity to reinforcement, of developmentally changing reinforcement hierarchies, and the course is run when Professor Ruebush insists that we must examine personographic variables in order to comprehend the effects of reinforcement.

This variety, if I do not mistake the markers and its unequivocal direction, suggests that "reinforcement" is not or is no longer a limited and delimitable construct in the order of "response rate" or "distal stimulus," but is a member of a more troublesome class of theoretical terms, a class that contains "anxiety" and "the unconscious." To put it another way, when we speak of reinforcement effects today, we do not discuss a set of facts—we discuss a set of theories. Neither the joys nor the problems described here are the property

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[1] This paper, with some modification, was delivered at a symposium on reinforcement effects, Society for Research in Child Development, Pennsylvania State University, March 16, 1961. The remarks apply to the papers delivered by Professors Bijou, Terrell, Zigler, and Ruebush.

of a particular point of view in psychology; they can be and, at some point, must be treated by all schools and theories.

The flight from reinforcement seems healthy. As a young psychologist said recently, "Great parts of the psychology of learning are devoted to demonstrations that the Law of Effect holds," and the several systematic attempts to go beyond this level of demonstration—attempts represented here—are surely welcome. The symposium has not asked, "What are the effects of reinforcement?" It has asked the immeasurably more searching question: "Toward what theory of reinforcement should we move?" Permit me to address this question, not with an intention of answering it, but rather to submit to your attention some of the problems for a theory of reinforcement that have appeared in the presentations just made.

1. *The problem of habit and performance.* This is a hoary issue that has become tarnished even in the halls of the committed, and I would not resurrect it if it did not appear to be of particular importance for child psychology. We may study variations in postasymptotic behavior—performance—as Bijou and his colleagues do in lever-depression work and as Zigler does in the marble-dropping task, or we may study more stable and more novel changes in response systems, as Terrell does in studies of discrimination learning. Ruebush attacks the problem in its most general form for child psychologists by asking to what degree reinforcement is to be used as a major transition rule in comprehending the development of the child.

The child psychologist who wants to make maximal use of the reinforcement notion in understanding development must have the reinforcement operation apply not only to changes in well-practiced behavior and to changes in motor and verbal skills, but to complex patterns or structures of behavior. I will return to this point in another context. I mean here to pose the question of the generality of the reinforcement operation, a question that will not be submitted to empirical analysis until conceptual and theoretical reworking is performed to clarify the range of intent—the domain of application—of the reinforcement operation. Does the same system of relations among variables in reinforcement effects hold for the control of postasymptotic behavior, for the learning of new skills, and for the changes in behavior (for which we scarcely have names) that occur as the child grows? In this last case, may I emphasize again that the pure experiment will not solve our problems; rather, we need a predictive system precise enough to direct the selection of relevant observations. In any instance, distortions will be introduced in our understanding if these classical differentiations between performance and learning are not made.

2. *The dimensions of the reinforcement operation.* It is in the systematic study of schedules of reinforcement, of delay and amount of reinforcement, of the effects of deprivation operations in relation to reinforcement, that significant and precisely replicable findings have been assembled. It is a reassuring lesson in the stability of psychological effects to see the regularity of the Washington observations and their neat analogy to data in other settings and other species, and it is particularly elevating of the Yale spirit to see the suggestive relations between Terrell's work on delay of reward in the discrimination behavior of children and the analysis of incentive that Logan is undertaking in a similar model.

Two arrays of theoretical and empirical problems in the study of the dimensions of the reinforcement operation appear in the symposium and, although they are not easy of solution, they are essential to our hoped-for general theories of reinforcement. One array is the prospect of quantifying at least some of the dimensions of reinforcement, in all likelihood by competition between dimensions—amount and delay, say—to establish equal-value pairs. The second problem, already under study in children by all members of this symposium, is the assessment of different reinforcers, of the relation between attention and approval, of social and nonsocial reinforcers, of the differential effect of negative against positive instances in a guessing game, and so on. This natural historical inquiry is now so various that it threatens to escape control, but the comparison of different reinforcement operations is a fertile area for systematizing research and theory.

It is easy for the official discussant to be brief in treating the dimensions of the reinforcement operation. There is a corpus of work related by theory and research in depth that hardly requires comment. The very strength of this hard-nosed part of the reinforcement problem requires a closer look at other aspects of reinforcement effect.

3. *The problem of the hypothetical child.* This difficulty is not quite so obvious in character and may be easily as important as the preceding problems. When an analysis of behavior is made for which the critical terms are input and output, stimulus and response, environment and behavior—and rules are sought to link these terms—one rarely finds a statement of the dimensions of the organism through which these rules operate. I do not mean by this to rehearse the obvious and rather uninteresting fact that there is an O between the S and the R—the deepest blue S-R-reinforcement theorist will concede this; what is crucial is that for any study of the input-output kind (as, for example, in a study of the stimulus dimensions of reinforcement) *particular* values of the organismic filter are assumed. The parameters of

subject variation are never set at zero—we can never assume that the black box is empty; rather, certain unmeasured and typically unindicated values of the organismic parameters are assumed. Clearly, the most commonly used are those derived from some measure of central tendency; that is, the input-output rules are held to operate across a set of what I would like to call state or structure parameters equivalent for all subjects under study and having the values represented by calculation of means or medians. Thus, for any statement of the classical form—response as a function of stimulation acting in the combination forms called theories—there is an implicit qualifier that the statement holds for a particular but unknown set of subject parameters: the parameters of the hypothetical child.

It is one of the impressive, although paradoxical, contributions of the researchers strongly influenced by Skinner that for many years they have insisted on an analysis of the individual case; in the language used earlier, they have taken for state parameters the system of input-output modifications that are typical of a single animal or person. It is an advance on thoughtless combination rules for subjects, but it introduces its own bias and this bias so seriously divides students of child behavior that I would like to speak of it briefly. If you examine the individual case (whether you study the effects of a VI schedule on pecking in ringdoves or the dream reports of a neurotic patient), and if you seek general laws of pecking or dreams, then the principles you establish—the lawful relations—are *precisely those principles that are not influenced by variation from person to person.* One can extract from the single case only what is true for another case and another and another until the general statement of relation is irreducibly true for all examined instances. The paradox, by no means amusing to me, of the intensive study of the individual case in search of general laws is that one must find at the end of the search a set of rules that have no room for individual variation.

The hypothetical child makes his apppearance in two ways: (*a*) as an assumed value of subject parameters or (*b*) as the case of universal communality. It seems appropriate, and everyone here has suggested it—Zigler and Ruebush most centrally—to *study* the variations that exist in the subject or, if that is not at the heart of one's interest, to recognize that among the external and visible variables lies a subject, at the very least a hypothetical child.

4. *The problem of the response.* The constructed or hypothesized child is nowhere more clearly seen than in discussions of response definition—

the thorn-and-thistle problem of rules for response aggregation and the formation of response classes. Now, the best-behaved hypothetical child is held to operate on an aggregation-by-reinforcement rule; that is, those topographically various responses that lead to or precede reinforcement are joined in a single functional class. The example used by all of us is the case of the left paw and the right paw of the rat being joined to a single class because they are not differentially reinforced.

Throughout the symposium is the statement, varying from suggestion to shout, that this way of approaching the problem of response classification will not do. At a level not altogether trivial, some responses are linked congenitally by anatomy or physiological function, but beyond this there are collections of response tendencies that move together in less than perfect correlation as a function of reinforcement, and we may justifiably suspect that these collections are not the same from one person to another, from one age to another, or from one setting to another. To select an obvious example, shock delivered to the foot of an infant in the first week of life will affect a far different combination of responses from the group affected when the same shock is delivered to the foot of a five-year-old child. As will be recognized, this problem of response aggregation is but a limited segment of the larger problem of reinforcement effects in the study of child behavior—namely, that reinforcement, however well-defined in stimulus terms or in terms of a general theory, does not operate on homogeneous material to effect homogeneous change. The transition rule that is represented by current conceptions of reinforcement operates on particular and on different initial hierarchies of response, on particular and on different valuations of reinforcing materials, and on particular and on different response-aggregation rules. Examples have appeared throughout the presentations you have heard, and I echo several earlier remarks when I make the following proposal.

In the study of reinforcement effects on the behavior of children, there is an obvious need to address ourselves to the problem of *structures of reinforcement*. It is a strange phrase—at least I find that it has difficulty getting past the teeth—but it sounds appropriate somehow. It sounds more appealing in the light of recent research, such as that of H. M. Jenkins on noncontingent reinforcement, which indicates that the reinforcement effect (the selection and strengthening of a response class to occurrence of tested and approved reinforcers) depends on the initial hierarchy, the structure, and the response state of the subject. In this proposal, I am not advocating a nonanalytic view of behavior. I am not even advocating a nonreinforcement view of behavior. I am maintaining the fact and the importance of the distinction between stable structures and systems of reinforcement receptivity and the specific effects of reinforcement in the usual learning (performance?) study.

We must seek out the dimensions of variations among subjects—the reinforcement psychologists of the child have always (but not always with happy results) been willing to accept age as such a dimension—that will permit us to describe and predict the shifts in behavior that take place with reinforcement. In a word, to achieve our comprehensive theories of reinforcement, we must develop (in addition to studies of stimulus dimensions) schemes for scoring or measuring the matrix of history and maturation on which reinforcement acts.

Let me add a terminal note of caution and hope. The cry cited earlier about endlessly replicated demonstrations of the Law of Effect will not be succeeded by a similarly extended list of demonstrations that its effectiveness and selectivity vary from one situation X to another situation Y. We know this too. The need is for a language and for specific empirical strategies in the study of the structures of reinforcement.

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THE MEASUREMENT OF MASCULINITY AND FEMININITY IN CHILDREN: AN EXTENSION AND REVALIDATION*[1]

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A. INTRODUCTION

In two previous publications (1, 2), the game choices of boys and girls were compared with those listed in the early work of Terman (8). These comparisons demonstrated marked changes in game preferences of boys and girls, and led to the development of new play scales for the measurement of masculinity-femininity. Based on games in a check list, the new scales were standardized on fourth-, fifth-, and sixth-grade children ($N = 183$).

Subsequent to standardization of the scales, it was found that high and low scorers differed on measures of anxiety (3), impulsivity (5), and neuroticism (6). Further, in a study of developmental shifts with age, it became clear that, while sex preferences were reasonably consistent up to and including the third grade, girls made considerable shifts in the fourth grade and afterwards. Such shifts indicated the desirability of discovering items that would transcend shifts in item preferences from grades three to six, inclusive. The present study represents an attempt to refine the earlier scales by replication of the original study on a larger sample, on a sample more widely spaced geographically, and on a sample that included pupils in the third grade. Such pupils were not included in the earlier studies.

B. PROCEDURE

A play scale composed of 180 games, pastimes, and activities (4) was administered to 973 girls and 928 boys in grades three through six in 12 Midwestern townships. Children responded to this scale by ignoring items that they did not play and by indicating like or dislike for items they did play. The preferences were subjected to chi-square analysis for sex differences and grade differences within each sex.

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C. Results

Results of our analysis are presented in Table 1. With the larger sample that covered grades three through six, we find that items that differentiate (at the .01 level) in favor of boys are similar to items in the original standardization. All items that, in the earlier study, discriminate at the .01 or .05 level in favor of boys are retained. Added to the scale are six items found significant in the present study. These items are baseball, basketball, fishing, climbing, "make radio," and "work machines." Earlier, we had found 24 items that favored boys at the .10 level of significance. In the present study, we find 25 items that favor boys at the .01 level of confidence.

TABLE 1

Game Choices Differentiating Between Boys ($N = 928$) and Girls ($N = 973$)*

Masculinity		Femininity	
Item No.	Game	Item No.	Game
8	bandits	1	dolls
9	soldiers	2	dressing up
10	cowboys	3	houses
13	cops & robbers	4	store
14	cars	5	school
18	spacemen	6	church
53	marbles	16	actors
64	bows & arrows	17	actresses
65	throw snowballs	30	stoop tag
113	darts	34	ring-around-the-rosy
128	wrestling	35	London bridge
129	baseball	36	farmer in the dell
131	football	38	in & out the window
133	basketball	41	drop the handkerchief
135	boxing	44	mulberry bush
139	shooting	47	hopscotch
157	fish	48	jump rope
158	hunt	49	jacks
164	use tools	87	Mother, may I?
168	climbing	156	dance
170	make radio	159	sewing
171	model aeroplane	161	cooking
172	toy trains	162	knit
174	work machines	163	crochet
178	build forts	175	cartwheels

* All items differentiate between the sexes beyond the .01 level.

Originally, at the .10 level of confidence, 43 items were found that differentiated in favor of girls. The present study yields 25 items that differentiate in favor of girls at the .01 level. For girls, 20 items (out of 33) that originally differentiated at the .01 level are retained. Excluded from the revised scale are all items that differentiated earlier only at the .05 or .10 level. Five new items, differential at the .01 level, are added. These items are church, actors, actresses, knit, and crochet. The similarity in numbers of items, and the same level of differentiating power, suggest that the original system of weighting items is no longer necessary (1).

To validate the present findings and to check the discriminating power of the revised scales, four groups of children (in grades three through six) were obtained from New York, Michigan, Illinois, and Idaho. Tables 2 and 3 present the distributions of scores for the four validation samples.

On the masculinity scale, the difference in means between boys and girls is significant beyond the .001 level of confidence for each group (t's = 18.8, 14.7, 17.2, 13.7). On the average, 8 per cent of the girls secure scores above the mean masculinity score obtained by boys. In samples I and II, the value is 6 per cent; in sample III, it is 11 per cent; in sample IV, 15 per cent.

On the average, 6 per cent of the boys secure scores below the mean masculinity score obtained by girls. In sample 1, the value is 4 per cent; in sample II, it is 7 per cent; in sample III, 5 per cent; in sample IV, 9 per cent.

On the femininity scale, the mean difference for boys and girls is significant beyond the .001 level of confidence in each of the four samples. (t's = 24.1, 26.2, 25.2, 20.3). On the average, 2 per cent of the boys secure scores above the mean femininity score obtained by girls (2 per cent, 2 per cent, 5 per cent, and 2 per cent in the four samples). Two per cent of the girls secure scores lower than the mean femininity score obtained by boys (4 per cent, 1 per cent, 4 per cent, and 1 per cent). On both scales, and in each of the four samples, the separation of boys from girls seems acceptable.

D. SUMMARY

A study of developmental shifts in game preferences in boys and girls suggested the desirability of an extension and revalidation of measures of masculinity and femininity obtained in an earlier study. The present investigation, based on 1,900 children, yields game-choice scales of masculinity and femininity for pupils in the third, fourth, fifth, and sixth grades. The items are similar to those obtained earlier, although there were more changes in items for girls than in items for boys. Validation of the revised scales on

TABLE 2

Distribution of Scores on the Masculinity Scale for Four Validation Samples

Scores	Validation I		Validation II		Validation III		Validation IV	
	Males ($N = 159$)	Females ($N = 137$)	Males ($N = 294$)	Females ($N = 263$)	Males ($N = 332$)	Females ($N = 325$)	Males ($N = 267$)	Females ($N = 245$)
0				3		1		
1		1				0		1
2		1		6		3		3
3		1		9		6		4
4		6	2	14	2	10	1	5
5		6	1	14	2	14	3	3
6		6	4	23	1	18		10
7	1	6	2	22	1	25		10
8	1	7	6	24	5	32	4	11
9	1	8	4	21	3	26	3	16
10	2	9	5	16	4	23	2	17
11	2	12	4	10	4	20	6	15
12	1	10	8	11	12	16	5	14
13	2	6	15	16	9	25	5	13
14	3	12	17	17	13	18	6	19
15	7	9	13	9	18	19	12	14
16	6	9	22	10	16	10	19	17
17	10	9	28	10	29	12	13	11
18	5	4	27	11	38	10	13	14
19	15	4	27	4	27	14	20	12
20	18	3	15	4	41	6	29	8
21	19	3	25	1	35	9	27	10
22	19	1	27	3	30	3	36	7
23	20	4	23	3	23	3	24	6
24	21		15	2	14	1	29	3
25	6		4		5	1	10	2
Mean	20.02	12.20	17.65	10.30	18.21	11.43	19.14	13.42
SD	4.32	5.16	4.24	5.21	4.28	5.37	4.09	5.47

TABLE 3
Distribution of Scores on the Femininity Scale for Four Validation Samples

Scores	Validation I		Validation II		Validation III		Validation IV	
	Males ($N = 159$)	Females ($N = 137$)	Males ($N = 294$)	Females ($N = 263$)	Males ($N = 332$)	Females ($N = 325$)	Males ($N = 267$)	Females ($N = 245$)
0	3		12		10		14	
1	5		27		13		22	
2	9		19		20		29	
3	5		23		33	1	26	
4	7	2	30		26	1	16	
5	15	1	26	1	25	2	28	1
6	10		23	2	25	5	17	2
7	5	1	24	6	24	4	16	3
8	10	1	23	6	24	6	21	4
9	16	1	18	5	24	8	12	2
10	13		14	8	18	5	16	4
11	10	2	10	6	18	15	9	6
12	11	4	13	14	9	12	8	9
13	8	4	7	15	11	10	5	7
14	8	7	7	20	11	19	5	11
15	4	17	10	17	11	24	7	12
16	4	5	12	32	6	25	5	15
17	6	12	1	25	6	20	2	19
18	6	10	2	26	4	30	3	20
19	2	4	1	24	4	28	3	28
20		15	1	24	4	24		24
21	2	9		15	3	28	1	24
22		24	1	9	3	25	1	16
23		11		4		15	1	17
24		3		3		9		13
25		4		1		9		8
Mean	9.20	18.26	6.55	16.12	7.86	17.00	6.51	18.04
SD	4.93	4.60	4.73	4.19	5.28	3.90	4.72	4.66

four geographically different samples resulted in acceptable levels of discrimination.

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PSYCHOANALYTIC THEORY ON INFANT GRATIFICATION AND ADULT PERSONALITY*[1]

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A. INTRODUCTION

What basic psychoanalytic theory links infant gratification and adult personality? Is there a relationship between infant indulgence and character? Does psychoanalytic theory adequately explain this relationship? These are some of the questions that will be examined in this paper.

First, several terms must be defined so that concepts to be used can be stated precisely.

Infancy is that period during which a child is completely dependent on parental care and before he has acquired the ability to verbalize his thoughts. It is that period of life during which weaning is completed and the initial phases of toilet training have begun. Thus, infancy is defined in terms of the mores of the society in which a child is raised.

Gratification denotes fulfillment of needs and desires. Indulgence implies immediate and complete fulfillment of any demand or request and the continuance of such a pattern long after it has ceased to be necessary.

According to Whiting and Child (18), gratification, or "initial satisfaction potential," can be measured on the basis of four factors, as these factors are expressed differentially in defined areas of infant experience. These factors are (*a*) the duration of the initial period; (*b*) the amount of freedom given the child to perform his initial habits; (*c*) the amount of encouragement for these habits; and (*d*) the amount of concurrent anxiety.

Adult personality must now be defined in such a way that its relation to infant gratification can be measured. The concept ego-strength is most appropriate.

Ego-strength is one's ability to cope with the problems of reality. Or, as Dollard and Miller would have it, ego-strength is strength of character (4, p. 63).

Fenichel (6) defines character as "the ego's habitual modes of adjustment

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to the external world, the id, and the superego, and the characteristic types of combining these modes with one another."

Freud (7, p. 62) links ego-strength with personal adjustment.

> The necessary condition for the pathological states . . . can only be a relative or absolute weakening of the ego, which prevents it from performing its tasks . . . . When the ego is detached from the reality of the external world, then, under the influence of the internal world, it slips down into psychosis.

Greenwald (9, p. 148) explains that neurotic behavior ". . . is essentially unrealistic in that is not adaptive to a given situation." Normal behavior, then, is action that is adaptive to a specific situation. Thus, Greenwald defines "normal" aggression as "aggression which is overt and directed at the environmental object which served to instigate the aggressive response. Any form of aggression which is not overtly directed at the instigator object will be labeled 'neurotic.' "

Erikson (5), like Freud, links ego-strength with effective functioning and, in addition, mentions the necessity for the child to secure a basic trust for, says Erikson (pp. 220-221), it is the absence of love, trust, and faith in the adult that marks the "psychotic character."

Our problem in this paper is to determine just how, and to what extent, a basic trust should develop, and how the development of such a basic trust is related to personality adjustment.

B. Theoretical Positions

1. *First View*

From one point of view, we can reason that a high degree of infant gratification leads to great need for parental love and approval since parental affection acquires value in itself—i.e., it becomes a secondary drive. If this argument is valid, such need leads to discipline based on fear of loss of love; fear of loss of love arouses anxiety, even if withdrawal of such love is not imminent or threatened; such an anxiety motivates social learning and leads to the formation of superego which represents parental authority.

As ego is defined as "that part of the psychic apparatus which is in contact with the environment and which mediates between the needs of the id and the demands of the superego" (17, p. 616), the stronger the superego, the less is the effectiveness of the ego and the lower is the ego-strength. As Freud (8, Chapter 5) has stated:

> Discords between Ego and Super-Ego have great significance for psychical life . . . . It is very important for mental health that the Super-Ego should develop normally—that is, that it should become sufficiently depersonalized. It is precisely this that does not happen in the case of a

> neurotic, because his Oedipus complex does not undergo the right transformation. His Super-Ego deals with his Ego like a strict father with a child, and his idea of morality displays itself in primitive ways by making the Ego submit to punishment by the Super-Ego. Illness is employed as a means for this "self-punishment." The neurotic has to behave as though he were mastered by guilt, which the illness serves to punish, and so to relieve him.
>
> The superego restricts the activity of the ego by means of prohibitions and punishments and facilitates or compels the setting up of repressions.

Since the superego functions toward the "limitation of satisfactions"—in contrast to the ego, which is "concerned with discovering the most favorable and least perilous method of obtaining satisfaction, taking the external world into account" (7, p. 19)—the stronger the superego, the less the individual is able to obtain satisfaction (i.e., to satisfy his desires).

We know that the inability of an individual to satisfy basic needs results in frustration and in a lowering of self-esteem; this leads to neurotic behavior that, as previously noted, indicates low ego-strength.

A summary of the argument thus far states that high infant gratification results in high superego development. High superego development results in low ability to obtain satisfaction (i.e., in low ego-strength), since satisfaction of demands made by the id is dependent upon "tension" between ego and superego. Silverberg (16, p. 73) explains the matter as follows:

> Psychic illness, then, implies illness of the ego—low self-esteem primarily occasioned by a diminution in the effectiveness of aggression. All of the ego's defensive devices, which are originally used to promote and improve this effectiveness, indicate that the ego does not feel itself strong enough, or safe enough to pursue the organism's aim directly; hence the devices emerge in an indirection which not only signalizes a relatively weak ego, but which in itself further weakens the ego.

After a thorough analysis of case studies, Levy (15) concludes that an overprotected child has a difficult time in social adjustment. Overprotection often results in selfish, demanding, undisciplined behavior. Maladjustment is proportional to the degree of dominance exercised by the mother.

By the mechanism described, excessive infant gratification results in a strong superego by a process of identification where parental norms are internalized to a great degree. Since the parents represent the norms of the culture, the child will internalize the same norms and consequently be oriented toward traditional modes of behavior.

While a tradition-oriented type of individual is mentally stable under conditions to which he is accustomed, he will be under extreme stress when faced with unusual or extraordinary circumstances. Under such circumstances, he may experience greater anxiety and mental impairment than will the individual who is not as completely governed by traditional norms and who, for that reason, is better able to deal with unusual circumstances. The latter individual employs adaptive (and often innovative) behavior (or values) appropriate for the solution of the problem. The latter individual has a strong ego; the former, a weak ego.

We might also summarize by saying that an overprotected child develops "low frustration tolerance." According to Heyns (11, pp. 254-255), such a child "has no experience with delay in satisfaction or with denial of gratification. When he experiences delay or denial, usually at the time when he leaves the narrow orbit of parental control, frustration is well-nigh intolerable." As a result of low frustration tolerance, an overprotected individual will be deficient in ability to meet demanding and challenging situations that are part of the world of reality. Such a person has low ego-strength.

To understand the relation between frustration tolerance and ego-strength, some comment on frustration is in order. Frustration is an internal state due to unsatisfied need or, in terms of learning theory, due to lack of drive reduction. Man is capable of being frustrated by his physical and social environments, by his own individual biological limitations, and by his psychological complexity. Ego-strength is a measure of one's ability to deal with such kinds of frustrating situations.

Heyns (11) argues that frustration is necessary for growth and learning; therefore, mental health depends on frustration tolerance—not on the development of inappropriate, unadaptive, or ineffective responses.

When an individual with strong ego is confronted with a threatening situation, he faces the threat, he analyzes it by exploring the factors responsible for it, and he takes whatever action is necessary and feasible to remove the source of tension and conflict. An individual with weak ego responds defensively, ignores or distorts perceptions that have induced the threat, and attempts to maintain his pre-existing self-structure rather than to adjust himself adaptively.

According to Jourard (14, p. 329), the relationship between strength of ego and adjustment to frustrating or threatening situations can be explained as follows:

> A strong ego enables a person to face reality—inner and outer—without distortion or selection, and to come to terms with this reality. When the ego is weak, the person ignores reality, or reconstructs it so as to make it conform with his wishes and needs . . . .
>
> [The mechanisms of defense] are modes of behavior undertaken by a person with a relatively weak ego, when threat to the self-structure arises. If they are effective, they reduce anxiety and guilt; but whenever the defenses are themselves weakened, threat is again experienced, for its causes continue to be operative.

Defensive reactions to threat are unhealthy because mechanisms of defense may be temporarily effective in reducing the guilt and anxiety caused by threatening conditions, but "they do nothing to remove the factors which are producing the threat" (14, p. 325). However, defense mechanisms are neither "abnormal" nor maladjustive in and of themselves. It is the manner in which they are employed—and the extent to which they are employed—that determines the degree of "adjustiveness" of the individual; i.e., his ego-strength.

2. *Second View*

Returning to the relation between adult personality and infant indulgence, Jourard (14, p. 264) presents another point of view.

> The child, as he grows, needs to experience unqualified affection and love. In the absence of this vital ingredient, the individual will suffer very low self-esteem, and will be subject to anxiety of powerful proportions.

Benedek (1, p. 195) agrees:

> By the same routinely returning process of gratifications, the infant acquires a sense of confidence that the mother will gratify his needs . . . it helps to decrease the intensity of the outer stimuli and this averts anxiety. Lack of confidence stimulates tension which may grow into discomfort and anxiety. This emotional shelter—confidence—and the positive dependent relationship to the mother which is its consequence, facilitates learning in the normal infant. The ego, strengthened by the libidinal relationship to the mother on the one hand and by the absence of anxiety on the other, develops an adequate capacity to perceive the objects of the outer world; such an ego is able to accept new and unexpected situations.

By the reasoning just indicated, infants raised in an atmosphere of restricted love, or without love and gratification, will have more anxiety than those whose needs are met with loving care.

In the first instance, tension and anxiety mark each step of adjustment to each new demand of each successive step of growing up. In the second instance, each new problem of adaptation is met with calmness and assurance, because each demand is learned through use of maternal love as secondary (or learned) reinforcement and as a substitute for the fulfillment of earlier needs. Such adjustment occurs because the need for love is acquired in connection with the early feeding process during which food and love are given to the infant at the same time. Thus, the need for love becomes a secondary (or learned) drive (due to the association of love with the primary need for food) and its fulfillment acquires secondary (or learned) reward value. Independence, therefore, can be developed at a natural (or personal) pace; but, according to Benedek (1, pp. 196-197), when parental love is not available,

> . . . the child, in order to avoid anxiety, finally refuses to respond and does not accept any new situation. If only the bare physiologic needs of a child are supplied, he may grow up to become a deeply inhibited person. For such an individual, every new situation will reactivate a part of that anxiety which he experienced as an infant. The individual who did not learn to love during the first year of life will be threatened whenever he shall develop a new object relationship . . . . Nursing care did not supply enough gratification to enable the infant to develop emotional-interpersonalized and intrapsychic-defenses against anxiety . . . . The ego's capacity to learn to master the object world goes hand in hand with the development of object libidinal relationship. The ego structure developing though the buffer of confidence has a greater span and flexibility in adaptation to reality. In contrast, if the psychic economy is not relieved by a sense of security in the relationship with the mother, but has to concentrate upon mastering and avoiding anxiety, it will produce an ego structure fixated to rigidly conditioned adaptation. Such ego structure may break down at any time when a new adaptive task emerges.

To Benedek (1, p. 199), however, satisfaction connected with the feeding processes lays the foundation for self-esteem.

> Primary self-esteem becomes the basis of ego development. Secure and stable, it is the core of a strong adaptable ego; helpless and insecure, it gives rise to a rigid ego structure which, under the strain of adaptive tasks arising later in life, may regress to the basic insecurity of early childhood.

Freud (7, p. 113) states that:

> . . . the ego comes to grief over the task of mastering the excitations of the first sexual period, at a time when its immaturity makes it incompetent to do so. We recognize the essential precondition of neuroses in this lagging of ego development behind libidinal development; and we cannot escape the conclusion that neuroses could be avoided if the child's ego were spared this task, that is, if the child's sexual life were allowed free play, as happens among many primitive races.

Does Freud mean that infant sexual satisfaction is directly proportional to adult adjustment (i.e., ego-strength)? It would seem so. Note, however, that we are investigating the more general aspect of psychoanalytic theory—that of overall infant gratification in relation to adult personality—rather than the more limited area which deals only with the child's sexual life.

C. SYNTHESIS

At this point, it would seem that a choice is available. On one view, overgratification leads to low ego-strength. On a second view, undergratification leads to low ego-strength. Both views appeal to Erikson. He writes (5, p. 247): "Case history after case history states that the patient had a cold mother, a dominant mother, a rejecting mother—or a hyperpossessive, overprotective one."

Horney (13) explains that, as a result of child-rearing by dominating, overdemanding, overindulgent, erratic, or indifferent parents, a child is likely to develop a "basic anxiety." Such anxiety results in general insecurity and in diminished ability for the child to attain a feeling of identity; i.e., to become meaningful to himself. Consciously or unconsciously, the child gradually realizes that there is only one way for him to fulfill his needs: through imagination. The child creates an idealized image and then identifies himself with this idealized image. The idealized image becomes an "idealized self," more real to the child than his real self.

Horney (13, p. 373) refers to the process just mentioned as a "comprehensive neurotic solution," because inner needs are satisfied and inner conflicts are resolved.

But this self-idealization inevitably develops into a powerful and comprehensive motivating force that is characterized by a general search for glory. The drive is compulsive. It influences every sphere of human experience. It is indiscriminate and insatiable. Due to its strength and comprehensiveness, the search for glory impels the individual onward "with an utter disregard for himself, for his best interests" (13, p. 378). The individual becomes unrealistic. His search for glory anesthetizes him, shields him from the full impact of outer reality.

While Horney (12, p. 18) maintains that basic anxiety, which is the cause of all neurosis, is due to feelings of insecurity and uncertainty that one is loved, Bettelheim (2) points out that "love is not enough" for the development of healthy, well-adjusted individuals. A child also needs discipline and punishment to learn the normative behavior patterns of his society.

Blum (3, pp. 33-34) summarizes the relationship between infant gratification and ego development in the following way:

> The newborn infant . . . does not have an ego. His ego becomes differentiated only under the influence of the external environment. He has no awareness of the outside world, and at best merely experiences sensations of pleasure and pain, or changes in tension . . . . The beginnings of ego functioning appear when the infant realizes that something has to

> be done by the outside world in order to have his tensions reduced. He now longs for "objects," persons, or things to satisfy his wants . . . .
>
> The distinction between self and environment centers about the indulgence and deprivation experienced at the hands of the mother. So long as all of the infant's needs are gratified, he continues to think only in terms of self. Some deprivation is essential before the distinction can be made. Theoretically, if every need could be immediately taken care of, a conception of reality would probably never develop. At the other extreme, intense deprivation also hinders ego development, for a certain amount of gratification is necessary.

Thus, Blum synthesizes the opposing views presented earlier. Either indulgence or deprivation—excessiveness to either extreme—can result in the development of a weak ego. Nevertheless, the question can still be raised as to whether an infant should receive more indulgence than deprivation, more deprivation than indulgence, or both in equal degree. Hartmann, Kris, and Loewenstein (10) believe that maximum personality maturation and adjustment—i.e., high ego-strength—is attained when a large amount of gratification is combined with a small amount of deprivation. If this is true, we would expect the relationship between ego-strength and gratification to be as shown in Figure 1.

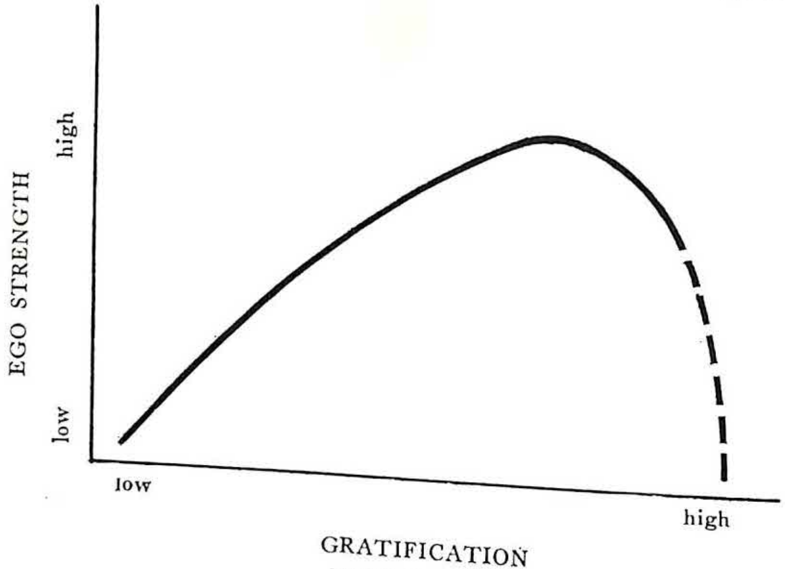

FIGURE 1
Hartmann, Kris, and Loewenstein View

Is the relation demonstrated in Figure 1 consistent with psychoanalytic

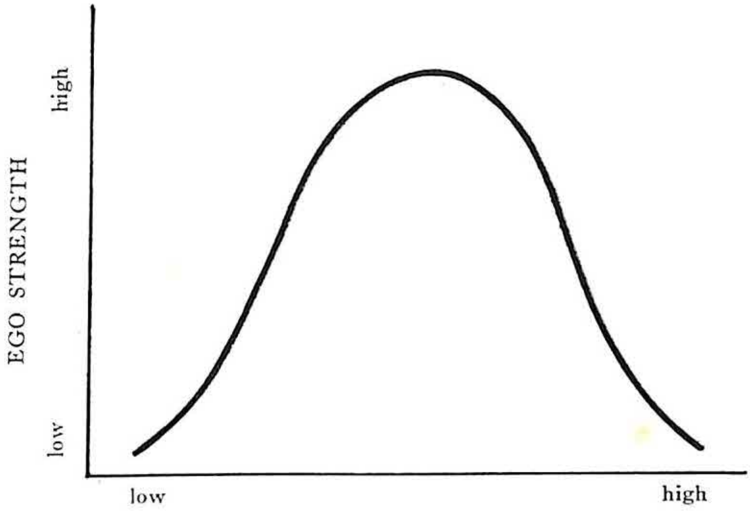

FIGURE 2
ORTHODOX PSYCHOANALYTIC VIEW

theory? Fenichel (6, pp. 65-66) summarizes the orthodox Freudian view by listing the types of experience that favor the development of fixation.

1. Excessive satisfaction or overindulgence at a given stage of psychosexual development to the extent that the stage is given up with reluctance, and frustration results in a "yearning for the satisfaction formerly enjoyed." Overindulgence makes the person unable to bear later frustrations.

2. Excessive frustration or deprivation at a given stage of development where the individual, lacking satisfaction at a particular stage of psychosexual development, "refuses to go further, demanding the withheld satisfactions."

3. Sudden and abrupt changes from excessive indulgence to excessive frustration at a given stage of psychosexual development, or vice versa (lack of continuity).

Fenichel, further, says that fixation predominatly occurs as a result of overindulgence (6, p. 65). Fixation hinders future development, and the personality consequently becomes rigid and "fixated" on a particular stage of development by means of the mechanism of regression. This is a manifestation of what we have designated as low ego-strength; inability to adjust to new situations as they arise.

As presented by Fenichel, psychoanalytic theory does not agree with the viewpoint stressed by Hartmann, Kris, and Loewenstein (10). Further, Fenichel has been vague about the degree to which overindulgence is more influential than deprivation in the causation of personality disorder. But more noteworthy is the fact that Fenichel mentions overindulgence in connection with fixation. While much of psychoanalytic theory concerns the fixated personality, fixated personality is not the only cause of maladjustment; yet the author has been unable to find any spokesman of orthodox psychoanalytic theory who has made a definite statement on the relationship of indulgence and deprivation to general personality adjustment. The author suggests that indulgence or deprivation (i.e., excessiveness to either extreme) has equal quantitative effects upon the degree of adjustment and the healthy functioning of a human individual. In light of the theoretical viewpoints presented, such an hypothesis does not appear unreasonable. Further, it seems a fair translation of psychoanalytic position. The view can be diagrammed as in Figure 2. In words, ego-strength is a normal-curve function of gratification. Too much gratification—or too little—leads to weak ego-strength.

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DISCRIMINATION, SERIATION, AND NUMERATION OF SIZE AND DIMENSIONAL DIFFERENCES IN YOUNG CHILDREN: PIAGET REPLICATION STUDY VI*[1]

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A. INTRODUCTION

The starting point for this sixth replication study is Piaget's book *The Child's Conception of Number* (8), which presents a variety of experiments dealing with many different facets of the child's number conception. Although some of the experiments reported in the book have been replicated by the writer (2, 3) and by other investigators, such as Estes (5), Wohlwill (11), and Dodwell (1), many experiments in the book remain to be explored by means of standardized procedures and statistical techniques. Of the experiments that remain to be explored, those relevant to discrimination, seriation, and numeration[2] of size differences were chosen for the present replication study because they provide a vivid illustration of the complex developments that underlie the child's attainment of an abstract number conception.

Piaget's experiments on discrimination, seriation, and numeration had a dual aim, as did all the experiments reported in his *Number* book. On the one hand, his experiments were designed to demonstrate stages in the development of particular conceptions—namely, that of a series and a seriated class (number). On the other hand, they were designed to demonstrate the development of a conceptualizing ability that transcends the formation of any particular conception and accounts for the similarity in the development of diverse conceptions. In his attempts to achieve his dual aim, Piaget encountered the same difficulties that learning theorists meet when they attempt to study learning apart from performance. Piaget's solution was to vary the problems and materials from experiment to experiment so that he could simul-

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[2] Piaget speaks of this problem as one of coordinating ordinal and cardinal number. But in fact, as he himself says elsewhere in his discussion (8, p. 157), the concrete problem is one of seriating classes (constructing numbers). The term *numeration,* though not Piaget's, is a convenient one to designate the application of numerals to a set of elements which are at once classed and ordered.

taneously demonstrate developmental sequences in the attainment of particular conceptions and, by comparison of these sequences with one another, demonstrate the unfolding of conceptual abilities that can account for the attainment of diverse conceptions. As Piaget does not always make clear the distinction between the dual aims of his investigations, he is frequently misunderstood.[3]

Implicit in Piaget's experiments on number is his assumption that conceptualizing ability derives from the internalization of the child's grouping, ordering, and counting actions—actions that, on the mental plane, give rise to class, relation, and arithmetic operations analogous to those of logic. In each of his experiments, therefore, Piaget presented children with problems of classification, seriation, and numeration that could be solved by the manipulation of concrete materials or by reference to them. By study of the development of the child's grouping, ordering, and counting activities in connection with concrete materials, Piaget hoped to discover the stages in the development of conceptualizing ability, as well as the stages in the attainment of particular conceptions.

Piaget's experiments on discrimination, seriation, and numeration provide a good example of his method. In one of his studies, he used two sets of size-graded sticks. The sticks in the second set were smaller than those in the first set. With his sets of size-graded sticks, Piaget devised three types of tests.

The first test was essentially a control measure and involved simple discrimination problems. For example, the child was asked to select the "largest" and the "smallest" of one set of sticks when the sticks were in disarray upon the table.

A second test involved presenting the child with several seriation problems. First the child was asked to build a "stairway" out of one set of sticks. After the stairway was constructed, the second set of sticks was produced—the child was told that they had been forgotten—and the youngster was asked to insert the new sticks within the stairway.

In the third test, the child was given several numeration problems. On the first problem of the test, the child was confronted with the intact stairway and was asked how many stairs a doll, occupying a particular stair, had had to climb to reach that stair. The second problem of the third test involved asking the child the same question when the stairway was broken apart so that the pieces were unordered as to size. The purpose of these numeration problems was to determine whether a child can coordinate an ordinal position with a cardinal value (the number of stairs climbed).

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[3] The study of Estes (5) provides a good example of such misunderstanding.

Piaget found that the discrimination problems were passed at the 4-year level, but that the more complex of the seriation and numeration problems were not passed until the ages of 6 or 7. Through careful analysis of the typical performance at each age level, Piaget was able to discern three stages in children's ability to seriate and numerate size differences.

At the first stage in the development of seriation (usually at age 4), children generally are unable to seriate sticks above a small number (three or four). At the second stage (usually at age 5), children are able to make a correct seriation after considerable trial and error, but are unable to insert the second set of sticks within the completed stairway. Children at the third stage (usually at the age of 6 or 7) are able to form a stairway and to insert correctly new sticks within it. Piaget observed parallel stages in the development of numeration. Children at the first stage (usually at age 4) are unable to count correctly and cannot determine the number of stairs the doll had climbed. At the second stage (usually at age 5), children are able to tell how many stairs the doll had climbed when the stairway was intact, but not after it was destroyed. Finally, at the third stage (usually at the age of 6 or 7), children are able to say how many stairs the doll had climbed, whether the stairway was together or was in pieces.

Numeration tasks were often performed with fewer elements than seriation problems because Piaget worked with the number of elements that the child could count correctly. With a fixed number of elements, the stages in numeration might well appear at a slightly later age than those reported for seriation. As a fixed number of elements were used in the present study, it was predicted that success on numeration problems would appear later than success on seriation items.

Piaget's presentation of his experiments raises several issues. First, Piaget reported the stages in the development of seriation and numeration by means of illustrative experimental examples of performances at different age levels —but without the aid of statistics. One purpose of the present study was to determine whether similar stages could be found, using standardized procedures and a statistical design.

Second, in discussing the developmental stages, Piaget intimated that the perceptibility of size differences might influence the age at which the stages appeared, but not the order of their appearance. A second purpose of the present study was to determine whether the perceptibility of size differences in one-dimensional, two-dimensional, and three-dimensional materials affects the ages at which the stages appear.

Third, Piaget interpreted the stages as favoring his thesis that the child's growing ability to form class, relation, and number conceptions derives from the conceptualization of his own grouping, ordering, and counting activities. However, as presented in *The Child's Conception of Number,* Piaget's argument is extremely condensed and difficult to follow, especially by those not versed in Piaget's terminology. A third purpose of the present study was to amplify Piaget's discussion on the development of seriation and numeration, with the aid of concepts and examples familiar to American psychologists.

B. Method

1. *Subjects*

Ninety children[4] (30 at each age level from 4 to 6) participated in the investigation. The median age for each group was (*a*) 4 years, 6 months; (*b*) 5 years, 7 months; and (*c*) 6 years, 9 months. The 4- and 5-year-old children were from the Wheaton College Nursery and the Country Day Nursery School in Norton, Massachusetts. Six-year-old children were from the Norton Elementary School.

Subjects were heterogeneous with respect to socioeconomic background and intelligence. The 4- and 5-year-old children at the Wheaton College Nursery had fathers who were in business or in the professions. On the other hand, in the majority of cases, the 4- and 5-year-old children at the Country Day Nursery School and the Norton Elementary School came from homes in which fathers were factory, farm, or office workers.

Despite the absence of measurement, it is assumed that the presence of children from a higher socioeconomic class in the 4- and 5-year-old groups raised the general level of intelligence in those groups above that in the 6-year-old group.

Piaget contends that the stages he observed are, at least in part, attributable to maturation and that differences in *IQ* and environmental stimulation should not obliterate differences attributable to growth. If differences between the 4- and 5-year-old children and the 6-year-old children are found, despite the likelihood that the older children have a lower mean *IQ,* the results would strengthen Piaget's argument on the importance of maturation in the attainment of conceptualizing ability.

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[4] The author is indebted to Mrs. Marjorie Ford, Director of the Wheaton Nursery School; to Mrs. Catherine Bauza, Director of the Country Day Nursery School; and to Mr. David Holbert, Principal of the Norton Elementary School, for their friendly cooperation.

2. *Materials*

a. Blocks. Two sets of size-graded blocks were used for the three-dimensional materials. In each set there were nine blocks. In the first set, the smallest block was a one-inch cube, and the succeeding blocks increased by ½″ increments. In the second set of blocks, the smallest block was a ¾″ cube; the succeeding blocks increased as in the first set. The blocks of both sets were painted a dull orange; the second set was distinguished by red markings.

b. Slats. For the two-dimensional materials, sets of size-graded slats were employed. All the slats were 1-½″ in width and ¼″ thick. The first set of slats began with a 1-½″ slat, and the succeeding slats increased in size by ½″ increments. The second set of slats began with a 1-¾″ slat, and the succeeding slats increased by ½″ increments. The slats were painted the same dull orange as the blocks, and the second set were identified by similar red markings.

c. Sticks. As one-dimensional materials, two sets of sticks, ¼″ in diameter, were used. The lengths of the two sets of sticks were identical to the lengths of the slats. Like the other materials, the sticks were painted dull orange and the second set had red markings.

3. *Tests*

a. Discrimination. The child was presented with four discrimination problems on the sticks, with four on the slats, and with four on the blocks. A set of nine blocks, slats, or sticks was placed in disarray upon the table and *E* said: "Can you find the smallest? Show me the smallest" (item 1). Then *E* said: "Can you find the largest? Show me the largest" (item 2). Next, *E* asked the child to hide his eyes and when the child did so, *E* disguised the smallest element so that it appeared larger. If it was a block, it was placed in front of other blocks. If it was a slat or stick, it was placed so that its upper edge protruded beyond that of the surrounding elements. The child was then told that he could look, and *E* said: "Find the smallest . . . now, show me the smallest . . ." (item 3). Once the child made his choice, he was asked to hide his eyes again while *E* camouflaged the largest element. If it was a block, it was hidden behind the other blocks; if it was a slat or stick, it was so placed that an element on one side of it protruded above it and an element on the other side protruded below it. Once more the child was asked to look, and *E* said: "Show me the largest . . . now, find the largest . . ." (item 4). Each correct choice was given a score of one. All other choices were scored zero. For any one material there was a possible score of four points. The total possible score was 12 points for the discrimination test as a whole.

b. Seriation. For each of the three materials, the seriation items were the same. With a set of nine elements in disarray on the table, *E* said: "Can you make a stairway with the . . . watch me." Then *E* constructed a stairway and made sure that the child watched the procedure. Then *E* mixed the elements and said: "Now, you make one just like mine." If the child failed to seriate nine elements, five were taken away and he was asked to seriate four (item 1). Children who failed to seriate four elements were not tested further. Those who succeeded on four elements were given seven elements to seriate (item 2). If the child failed with seven elements, testing was discontinued. If the child succeeded, he was again given nine elements to seriate (item 3). If the child failed after having seriated four and seven elements, testing was discontinued. Those children who initially, or eventually, were able to seriate nine elements were given five additional elements (picked at random from the second set) and *E* said: "I have some more . . . that also go in the stairway; can you put them where they belong?" (Item 4). If the child did not get the idea, *E* demonstrated with one element. Each correct seriation item was given a score of one and, if the child initially succeeded in seriating all nine elements, he was automatically given a point for seriating four (item 1) and seven (item 2). On any one material there was a possible score of four points and a total possible score of 12 for the seriation test as a whole.

c. Numeration. The numeration items, like the seriation items, were the same for all materials. With the elements made into a stairway, *E* asked the child to count the number of stairs (item 1). *E* then said: "Look, a dolly is on this stair." (*E* points to the first stair.) "How many stairs does the dolly have to climb to get on this stair?" Once the child got the idea, *E* pointed to each stair in succession, asking how many stairs the doll had to climb to reach each stair (item 2). Then *E* pointed to the fourth stair and said: "How many stairs must the dolly climb to reach this stair?" After the child's reply, *E* pointed to the seventh stair and repeated the question. For this question (item 3), the child had to tell how many stairs the doll had to climb to reach *both* the fourth stair and the seventh stair to receive credit. Next *E* mixed the elements and said: "If the stairway was together like it was before, how many stairs would the dolly have to climb to reach this stair? (the fourth) . . . and this one?" (the seventh). On this question (item 4), the child had to tell how many stairs the doll had to climb to reach *both* the fourth stair and the seventh stair in order to receive credit. For any one material there was a possible numeration score of four and a total possible score of 12 for the numeration test as a whole.

4. *Procedure*

Each child was tested individually three times at intervals of approximately one week. At each test-session a different material was employed. To control for practice effects, the order of presentation of the materials was counterbalanced. At each age level, the 30 children were randomly assigned to one of six subgroups with five children per group. Each subgroup was presented with the materials in one of the six possible orders in which the three materials could be combined.

5. *Experimental Design*

As can be seen from the description above, the experiment involved three independent variables: Age, Materials, and Tests. For two of the variables, Materials and Tests, it was possible to administer all the values of each variable to every child. For the third variable, Age, this was impossible; and each value was represented by a different age group. For two within-group variables and one between-group variable, an appropriate design is described by Lindquist (6). That design, Type VI, was used in this study. Because the scores in the individual cells were small, with consequent small-error terms, the author decided to use the .01 level as the criterion for rejecting or accepting the null hypothesis.

C. RESULTS

1. *Quantitative Findings*

The results of the analysis of variance are shown in Table 1. The various individual tests will be discussed below.

a. Age. Piaget's observations imply significant differences between 4-, 5-, and 6-year-old children in the ability to discriminate, seriate, and numerate size differences. In the present study, the F for these three groups was 52.5 and was significant beyond the .01 level of confidence. The means for the three age groups were 21.2 (age 4), 29.7 (age 5), and 32.0 (age 6). Individual t tests for the differences between means indicated that they were significantly different from one another at the .01 level. The increase with age in the size of the mean scores on tests of discrimination, seriation, and numeration is in agreement with Piaget's observations.

b. Tests. In his experiments, Piaget found that the discrimination items are the least difficult, that the seriation items are of intermediate difficulty, and that the numeration items (when not made easier by reducing the number of elements used) are the most difficult. Results of the present study gave an F for the three tests of 132.3, significant beyond the .01 level. The means for the three types of test were 11.6 (discrimination), 8.7 (seriation), and 7.4 (numeration). These means were significantly different from one another as shown by individual t tests. Item analysis revealed that the last item of the seriation test (the insertion problem) was the most difficult of the seriation problems and that the last item of the numeration test (the determination of the number of stairs climbed after the stairway has been destroyed) was the most difficult of the numeration items and, in fact, the most difficult item of all items. The relative difficulty of the three types of test and of the individual items of those tests is consistent with Piaget's results.

c. Materials. Although Piaget did not to any great degree concern himself with the dimensional characteristics of his test materials, he did suggest that the more perceptible the differences, the more easily they would be mastered. In the present study, this suggestion was tested by varying the dimensionality of the materials. This was done on the assumption that variation in dimensionality might reveal whether successful discrimination, seriation, and numeration of six differences is a function of their discriminability. The F for the three materials was 24.1, significant beyond the .01 level. Individual means were 8.8 (sticks: one-dimensional materials), 9.1 (slats: two-dimensional materials), and 9.8 (blocks: three-dimensional materials). By individual t tests, the differences between means were significantly different at the .01 level. Although the extent of the differences was not great, there was a trend toward more successful discrimination, seriation, and numeration of size differences with an increase in the dimensionality of the materials in which those differences appear. The finding agrees with Piaget's suggestion on the influence of the perceptibility of size differences.

d. Age × Test interaction. According to Piaget, the difference between success on discrimination, seriation, and numeration tests decreases with age because of the increased conceptual ability of the older child. On account of the increased conceptual ability of the older child, one would expect that differences between the three tests would vary between age levels. Statistically, an unequal effect of the tests at each age level would appear as a significant Age × Test interaction. The F for this interaction was 20.5; significant beyond the .01 level. As expected, the table of interactions for these two variables showed that differences between mean scores on tests of discrimination, seriation, and numeration decreased with age, in agreement with Piaget's findings.

e. Age × Materials interaction. Although Piaget assumed that the perceptibility of differences might influence the ease with which differences are discriminated, seriated, and numerated, he also assumed that perceptibility of differences does not affect the *order* in which items are passed; rather he held that the order reflects a necessary sequence of development. If Piaget is correct, the differences between age groups should remain relatively the same for each material, although the absolute size of the scores might vary from material to material. In that case, one would not expect a significant Age × Materials interaction, but a significant interaction effect would lead to rejection of the hypothesis that the effects of age are the same for all materials. The F for this interaction was 2.5 and was not significant at the .01 level. In short, it seems reasonable to accept Piaget's view that perceptibility of size-differences affects absolute score-differences, but not relative score-differences between age groups on different materials.

f. Tests × Materials interaction. Piaget's position implies that the effects of varying the perceptibility of size differences are more pronounced on difficult tests than on easy tests. If this view is correct, one would expect the effects of materials to be different on different tests and this would appear as a significant Test × Materials interaction. The F for this interaction was 4.7, significant beyond the .01 level. Examination of the table of interactions indicates that the effects of the dimensionality of materials was greatest for the discrimination and the numeration tests and was least for the seriation items. This finding was not expected. It may be that discriminability had the most effect with discrimination and numeration because the children were not as active on these tests as they were on the seriation test; therefore the immediately given differences were of greater significance. Naturally, this hypothesis needs to be checked in another study. It can be said, however, that the effect of the discriminability of differences varies according to the nature of the test.

g. Age × Test × Materials interaction. There was no reason to expect, on the basis of Piaget's findings, that the effects of particular tests and materials would be different at different age levels. In the present study, the test of these particular combinatory effects was tested by the Age × Test × Materials interaction. The F for interaction was 2.1 and was not significant at the .01 level of confidence. Accordingly, the results of this study give no warrant for assuming that the effects of the combination of any one material and any one test varies with age level.

2. *Qualitative Observations*

In order to make the foregoing statistical results concrete and to convey some of the behavioral details upon which Piaget builds his interpretations of conceptual development, illustrative examples of performances observed in the present study will be presented. These behavioral observations will also serve as a bridge between the statistics of the preceding section and the theoretical discussion which is to follow.

a. Stage 1.

(1). *Bob* (*4-7*). Bob picked the smallest slat after briefly surveying the elements. For the largest slat, he chose one of the largest elements; when asked whether it was really the largest, he nodded in assent. Bob found the smallest slat when it was disguised but chose the stick that stuck out the farthest in his attempt to find the largest slat.

On the seriation test, Bob arranged the slats in disconnected pairs: GE, HB, EA, etc. In other words, he made several seriations that lacked direction and exactness although the general idea of size differences was grasped. Bob was not able to seriate four slats, and seriation testing was stopped.

When asked to count the steps in the stairway (which *E* constructed), Bob said: "1, 2, 3, 7, 5, 9, 11." In his attempts to attach these numbers to individual elements, he sometimes counted the same element twice and at other times skipped elements altogether. Bob was not able to grasp the doll-and-stairs problem.

(2). *Hal* (*4-6*). Hal picked the smallest slat and the largest slat after carefully comparing them with several others. When the smallest slat was disguised, he found it immediately. On the other hand, he was not sure of the largest stick and said: "I'd better measure," which he proceeded to do. (This is an excellent illustration of Weber's law; i.e., a half-inch differential in length is easier to perceive between short elements than between long ones.)

On the seriation test, Hal put down CABEGFIH but arranged them so that the tops of the elements made a regular stepwise pattern. *E* then placed a straightedge along the bottom of the series so that the elements were evenly aligned, but the tops of the elements no longer made a regular stepwise pattern. Immediately, Hal arranged the elements in the stepwise pattern again without regard to the size relations among them. Hal seriated four elements correctly and succeeded with seven elements after some trial and error. But when he had nine slats again, he once more ordered them by arranging the tops in a stepwise pattern.

When Hal was asked to count the stairs in the stairway on the first numeration item, he counted 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, but in his eagerness skipped an element and said there were 10 elements, not nine. *E* asked Hal to count slowly, which he did, and he determined the correct number. When Hal was asked how many stairs the doll had climbed to reach the first step, he tried to count all the steps again. He was not able to get the idea that the number of stairs climbed was determined by the number of the stair.

b. Stage 2.

Helen (*5-4*). Helen selected the largest and the smallest slats quickly. She did this when they were scattered as well as when they were disguised.

On the seriation test, Helen arranged the elements ABDCEGF and then recognized something was wrong and rearranged the elements several times until she got them right. Then she put H and I together on one side as if the other elements formed a completed series and as if she were starting a new one. When *E* asked: "Can you make these [H and I] into the stairway, too?" Helen added them but reversed the H and I and then got them correctly. When *E* produced five more slats from the second set, Helen attempted to build a second stairway alongside the first. After *E* demonstrated insertion with one element (c), Helen placed c in the stairway but removed C and then she put in f, but removed D. *E* said: "They are all supposed to fit in the stairway. Can you put these [the unseriated pieces] in?" Helen put them all in, but in egregiously wrong places, so that the series was AdBCgDcEFaGHIh. When she was asked: "Are they just right?" Helen replied, "Yes."

With the numeration items, Helen had some success. She made no errors in counting the stairs or in grasping that the number of stairs climbed could be determined by the number of the stair occupied by the doll; nevertheless, she did say that when the doll was on the fourth step it had climbed three stairs and that when it was on the seventh step it had climbed six stairs. When *E* (pointing to the fourth step) asked, "But didn't the doll climb this step?" Helen answered, "No, because the doll is on it." (Apparently, at Stage 2, climbing and being on the stair are mutually exclusive concepts. This difficulty in logic is encountered in the formation of many concepts. At a certain stage, youngsters think a boy cannot be a child and a boy at the same time (3). Likewise, at a certain stage in the development of the concept of religious denomination (4), the child thinks that he cannot be an American and a Jew at the same time.) When the stairway was broken, Helen disregarded the order and counted whatever elements were to the right of the designated stair to determine the number of stairs climbed.

c. Stage 3.

(1). *John* (*6-4*). John quickly dispensed with the discrimination items. On the seriation test, John started with the largest slat, I, and each time selected the largest of the remaining elements. He made no errors and the series was constructed in less than a minute.

With the numeration items, John had equal success. He counted the elements correctly; he knew how many stairs the doll had climbed when the stairs were pointed to in succession and when they were pointed to at random. When the stairway was broken, he put it together again to determine how many stairs preceded the designated stair.

(2). *Al* (*7-1*). Al performed much like John on the discrimination and seriation items.

On the numeration test, Al was able to tell not only how many stairs the doll had climbed when the stairs were in disarray, but he was able to do so without actually reconstructing the stairway. In addition, when he was asked to say how many stairs the doll would have to climb to reach the top, he did so by subtraction and without reference to the stairway.

The foregoing examples could be multiplied many times to bring out additional nuances and transitional stages in the development of the ability to discriminate, seriate, and numerate size differences; nevertheless, it is hoped that the examples given will make plausible the interpretations to be presented in the concluding section of this paper.

D. Discussion

In the preceding section, the author presented quantitative and qualitative evidence that is in general agreement with Piaget's observation on the development of the concepts of series and number. Piaget interpreted his data from the standpoint of his genetic psychology of intelligence (8). According to Piaget's psychology, conceptualizing ability derives from the internalization of the child's own actions; stages in the development of particular conceptions reveal the sequence of this internalization. In the following pages, an attempt will be made to recapitulate Piaget's interpretation, to extend it, and to make it more concrete than it is in *The Child's Conception of Number*. Obviously, the attempt will involve some bias and distortion, but it is hoped that the presentation will stimulate others to read Piaget and to reach their own conclusions.

1. *Development of Seriation*

a. Stage 1. At the first stage, the child has only a general impression of a series as a kind of *global* figure in which the whole and the parts are undifferentiated. It is a purely perceptual impression, however, for as soon as the stairway is destroyed the child no longer believes in its existence. Thus, when the child attempts to reconstruct the stairway, he builds disconnected pairs of elements, AC, DG, HB, and makes no attempt to coordinate them. On the other hand, the child's judgment of individual size relations is generally correct, as is shown in his success with the discrimination problems. The two facts—inability to order pairs of relations, and the correct judgment of single relations—show clearly that the child's difficulty is one of coordinating relations as well as of forming a mental representation of the series.

The child's difficulties at the first stage are analogous to those of the infant at the initial stage of the construction of the object (9). At that stage, the infant ceases to look for the nipple once it has disappeared from sight, even though he is perfectly capable of turning the bottle around so that the nipple is once more accessible. This occurs because the infant is as yet unable to coordinate the visual impression of the back of the bottle with the visual impression of the front of the bottle, just as the older child is unable, at the first stage in seriation, to coordinate individual size relations with the impression of the series as a whole. In the initial stage of construction of object, as well as series, the child mistakes the absence of visual impression for the absence of the real object. He does this because he is unable to make the coordinations that would give the object psychological permanence.

b. Stage 2. When the child has reached the second stage (usually age 5), he has attained what Piaget calls an *intuitive representation* of the series as a whole made up of unrelated differentiated parts. It is intuitive representation, a kind of mental picture of the series, that enables the child to construct, after considerable trial and error, a correct seriation in the absence of a model. However, the imaged character of the representation accounts for the child's trial-and-error method and for his inability to insert a second set of elements within a completed series.

The child's trial-and-error behavior involves a beginning coordination of relations, inasmuch as the child eventually reaches a correct seriation, but the coordinations that lead to correct seriation are the *result* of the child's trial-and-error behavior and do not cause it. The reason for the child's trial-and-error behavior is the fact that he tries to construct a figure analogous to his mental representation of the stairway, but the child's mental representation of the series is different from that of an adult.

The adult conceives the series as a set of elements in an order that can be indefinitely extended, whereas the second-stage child imagines the stairway to be a set of elements related only by the fact that they join to form a pattern; consequently, when the child tries to reconstruct the pattern from a set of unordered elements, he regards each element as unique. He can think of no systematic way of selecting them. Put differently, at Stage 2, the child's problem of constructing a series is analogous to that of putting together a jigsaw puzzle; for the adult, the problem is analogous to the construction of a rank order.

It is because the child sees the problem of seriation as a kind of jigsaw puzzle that he selects elements at random and joins them without regard to their size relations. However, when this unsystematic method results in a figure that differs from his imaged representation of the stairway, then, and only then, does the child begin to coordinate the size relations among the elements. For example, if the child places B next to C and A next to C, then the result, BCA, fails to agree with his mental image of the stairway. He then moves A next to B and achieves the seriation, ABC. However, it must be emphasized that the coordination of relations, $A < B < C$, is neither spontaneous nor deduced and is achieved only because of the discrepancy between the imaged and the perceived figures.

The imaged character of the child's representation—or its figural character—at Stage 2 also accounts for the child's strange behavior; i.e., strange from an adult's point of view, when he is confronted with the problems of nesting one set of elements within another. When the second-stage child is given additional elements to insert, he does one of three things: (*a*) he constructs a second series alongside or atop the first, (*b*) he exchanges elements rather than adds them, or (*c*) he inserts elements without regard to their size relations and regards such insertions as correct.

All of these behaviors "make sense" to the adult once it is realized that as soon as the child has completed his stairway, the child regards it as a completed figure or picture to which nothing more can be added. It is for this reason that, when he is given additional elements and is asked to put them within the completed stairway, the child is as baffled as if he had just completed a jigsaw puzzle and were given additional pieces to put within the finished picture. Since he cannot understand how the pieces are to be inserted, he thinks he has not understood *E* and assumes that *E* wants a second stairway, or an exchange of elements, or a longer line of elements. It should be clear, however, that the child's failure to comprehend the directions does not derive from a verbal misunderstanding. He understands what is wanted prefectly well, and *it is because he understands that he is baffled by the problem.*

At Stage 2, the child's performance on the insertion problem complements his trial-and-error attempts at seriation. In trying to form a series, the child does not spontaneously coordinate the relations $A < B$ and $B < C$, etc.; he does so only in connection with discrepancies between perceived and imaged figures. Likewise, when faced with the problem of insertion, the child does not spontaneously attempt to coordinate the relations of the elements to be inserted with those already seriated. Because there is a completed stairway that makes an appropriate match to his mental image of a series, he feels no need to incorporate the second set of elements within the first. So at the second stage in seriation, as at the first, the child's failures are attributable to failures in coordination of relations and the advance of the second-stage child over the first-stage child derives from the fact that, by means of a differentiated image of the stairway, the second-stage child is able to make such coordination and construct a series.

c. Stage 3. At the third stage (usually ages 6-7), the child attains what Piaget calls an *operational* concept of a series. Piaget speaks of the concept as operational because the acts of coordination (ordering) begun at the second stage have gradually become internalized and, in the process, take on the characteristics of logical operations. Once the child's ordering activities have become operations, new coordinations—not possible on the intuitive or perceptual planes—make their appearance. For example, at the third stage the child can mentally coordinate the relations $A < B$ and $B < C$ and arrive at the relation $A < C$ without actually comparing A and C as would be necessary on the plane of perception or intuition. Likewise, at Stage 3 the child can mentally order the series in two directions at once, either as $A < B < D < E < F < G$ or as $F > E > D > C > B > A$, whereas on the perceptual plane, as is known from the staircase illusion, he can perceive a stairway as going up or down but not both ways at the same time. In short, the internalization of ordering activities transforms the child's perception (and representation) of the series because he attributes to that perception the results of his own mental activity, whereas previously he merely read the perceptual givens.

In Stage 3, the attribution of the results of mental activity to perception is clearly apparent in the child's seriation. It is marked by rapidity, few errors, and by construction in either direction. To construct a series systematically, as third-stage children do, it is necessary to attribute to each element the relation s $>$ r and s $<$ t because (to form a series) each element must be chosen so that it is smaller than each element that follows it and larger than each element that precedes it. Such attribution cannot be accomplished on the plane of perception or intuition. On these planes the relations s $>$ r and s $<$ t are contradictory and cannot be combined to give a meaningful conclusion. The situation is analogous to the double alternation problem in which the same stimulus points in two different directions at the same time. In the double alternation problem, as well as in the seriation problem, the correct solution can be found only by means of symbolic or operational processes.

With respect to seriation, the coordination of s $>$ r and s $<$ t is accomplished because the child can mentally order the series in two directions at once. When this is done, the child discovers that the relations s $>$ r and s $<$ t are not contradictory but complementary, because they refer to differences in direction—not to differences in substance—and are equivalent to the relations r $<$ s $<$ t. Simultaneously, the child is then able to attribute both relations to (s) and is able to construct a series. However, it must be emphasized that the child would not be able to do this on the perceptual or intuitive plane. He accomplishes it because, at the third stage, he is capable of mentally ordering elements in two directions at once and of attributing this dual relation to particular elements.

Similar reasoning explains the child's rapid and errorless insertions at Stage 3. First of all, at Stage 3, the child attributes relations to the series and is no longer deceived by its whole quality. In other words, he does not assume that the series is complete and that nothing more can be added. Second, when he picks each element for insertion, say c, he is confronted with the same problem that he encountered in seriation: namely, that of attributing two relations c $>$ C and c $<$ D to c. He resolves the problem by recognizing the equivalence of the relations just mentioned to other relations formed by ordering the elements in a different direction. In short, both seriation and insertion are accomplished rapidly and without error because the third-stage child is able to attribute the results of his mental operations to the perceived elements; in this way he finally overcomes the apparently contradictory relations given in perception.

2. *The Development of Numeration*

The development of numeration (the assignment of numerals to elements regarded as classed *and* ordered) parallels the development of seriation and classification (3) because the coordinations involved in forming series and classes are also involved in forming seriated classes (numbers). The coordinations involved in forming series and classes are differentiated from those involved in forming seriated classes by the fact that, in attempting to construct a number conception, the child is dealing with elements that, at once, can be ordered *and* classed. Thus, the development of number can be viewed as an attempt to coordinate asymmetric (series) with symmetric (class) relations. This view makes immediately clear the essential unity between the three processes of seriation, classification, and numeration.

a. Stage 1. At the first stage (usually age 4), the child has only a global impression of seriated class in which the quantitative differences and the similarities among the elements are undifferentiated. For example, when the child attempts to count the steps of the stairway (disregarding for the moment whether the sequence of numbers he uses is correct), he neglects the differences (and skips elements) ; he also neglects the similarities (and counts the same element twice). The reason for this behavior is similar to that for global seriation: namely, the child's inability to coordinate relations that, in this case, are the symmetric (class) and asymmetric (difference) relations. Inasmuch as counting for the adult is always the simultaneous ordering and classifying of elements, it is clear that counting for the 4-year-old child is simply an imitation of adult behavior. It is not a true coordination of class *and* order relations. Such a coordination is impossible at the first stage because, at that level, classes, series, and seriated classes do not exist in the adult sense of these terms.

b. Stage 2. The child at the second stage (usually age 5) has a differentiated representation of seriated class. Piaget calls such representation intuitive. This intuitive representation amounts to a kind of ambiguous figure that (disregarding differences) can be imaged as a collection of elements similar in appearance or (disregarding similarities) can be imaged as a collection of elements different in size. It cannot be imaged as both at once. This reversible representation of seriated class accounts for the successes and the failures of the second-stage child on the problem of the doll and the stairs.

When the stairway is intact, counting the elements necessarily induces a recognition of their similarities (a sort of reversal of perspective), just as a counting of the unordered elements induces a recognition of their differences. For this reason, when the stairway is intact, it is relatively easy for the child to think of a class in terms of a position. Once the child has counted as far as the stair that the doll occupies, he immediately reverses perspective and sees the stairway as two classes made up of those stairs greater than the number of the stair that the doll is on and of those stairs smaller or equal to the number of the stair that the doll is on. By this method, which amounts to a perceptual rereading of the situation, the child can literally see that the class value of the stairs climbed equals the series value of the stair occupied by the doll.

The proof that this is not a true coordination of series and class values comes from the observation that the child cannot coordinate these values once the stairway is destroyed. When the steps of the stairway are no longer together, the child disregards order and merely counts whatever steps are to the right or to the left of the step occupied by the doll. The reason is that, when the child views the unordered pieces, he recognizes that the unordered pieces can be seriated (since he has already used them to form a series) and that they can be classed (since he has already divided them into two classes to determine the cardinal value of the stairs climbed), but what he cannot do, in the absence of a stairway, is to recognize that the elements can be classed and seriated at the same time. This inability is attributable to the fact that, at Stage 2, the seriated class is a kind of reversible image such that awareness of the one figure automatically destroys awareness of the other.

In the development of numeration, as in the development of seriation, the advances and the limitations of the second stage are determined by the presence of a representational figure. In the seriation problem, the representational figure forces the child to coordinate his construction with the representational image. In numeration the perceptual figure forces the child to reverse the perspective of his representational image. In short, the coordinations that appear at the second stage are due to the matching of mental images and perceived configurations and do not represent a prior understanding that the figure can be constructed by a coordination of relationships.

c. Stage 3. At the third stage (usually ages 6-7), the child has attained what Piaget calls an *operational* conception of an ordered class. It is an operational conception because the actions of ordering and classifying, begun at the second stage, have become internalized and have, in the process, taken on the characteristics of logical operations. Once ordering and classifying have become operational, they are potentially capable of being carried out simultaneously. On the intuitive plane they can only be performed sequentially.

Although the coordination of classification and ordering is made possible by their emergence as operations, their coordination into numerical operations cannot actually be achieved without the aid of counting. The reason is as follows: to coordinate the symmetric and the asymmetric operations simultaneously requires that there be actual relations that are at once similar *and* different. No such relations exist on the perceptual or intuitive planes. The perceived relation $A = A'$ (say, in color) cannot be an asymmetric relation, just as the relation $A < A'$ (say, in size) cannot be symmetric. Counting, however, disregards both the perceptual similarities and the perceptual differences and renders elements simultaneously alike, in that they can be counted, and different in the sense that each element has a unique position of enumeration. In other words, counting transforms each element into a *unit.* Once elements are regarded as units, the classificatory operation $A + A' = B$ is transformed into the numerical operation $A + A' = 2A$; the ordering operation $A < A' < B$ is transformed into the numerical operation $A + 2A = 3A$.

It must be remembered, however, that counting achieves the transformation of elements into units only after classification and seriation have become internalized, for only their operational character makes their simultaneous coordination possible. Counting merely provides the concrete materials (units) on which this coordination can operate and, as the preceding discussions of the first and second stages show, does not spontaneously give rise to numerical relations. Put differently, only after seriation and classification become operational is counting regarded as attributing a unit character to each element counted.

At the third stage, the attribution of a unit character to the steps of the stairway is clearly evident in the child's performance on the doll-and-stairs problem. The youngest or least advanced of Stage 3 children reconstruct the entire stairway before counting to the designated stair. More advanced youngsters construct the stairway only as far as the designated stair, but the most advanced children do not even bother to reconstruct the stairway and perform the seriation mentally. Each of these behaviors demonstrates that the child attributes to the stair occupied by the doll both a series value (since he actually or mentally reconstructs the stairway to determine its position) and a class value (since he uses the number of the stair occupied by the doll to say how many the doll climbed). This occurs because counting, at first actual, then mental, transforms each element into a unit.

Once counting renders each element a unit, the operations of seriation and classification applied to these units result in numerical operations. This is not surprising for, as Stevens (10) has pointed out, numerical operations are appropriate only to elements ordered so that differences between successive elements are equal. Counting thus transforms the stairway into an interval scale that is amenable to arithmetic operations. In their turn, arithmetic operations are nothing other than the operations that are involved in seriating and classifying, as applied to elements, the perceptual similarities and differences of which have been disregarded, and that, as elements, have been rendered simultaneously alike and different by means of the child's actions. The proof that seriating and classifying operations are numerical as applied to units can be observed at the third stage. When the third-stage child has correctly determined how many stairs the doll has climbed by reconstructing the stairway and is asked how many stairs the doll must climb to reach the top, he does not count, but solves the problem by subtraction. That is, once the child has counted the total number of stairs (X) and the number up to and including the stair occupied by the doll (N), he knows immediately that the number remaining to be climbed is $X - N$. In short, classificatory and difference operations become numerical as soon as the members of the class and the series are regarded as units.

Thus, there is an essential unity between conceptual and numerical ability. Both types of ability derive from an internalization of the child's classificatory and ordering actions that become an integrated set of mental operations with logical characteristics. When this system of operations is applied to elements regarded as similar, the result is a classification; when applied to elements regarded as different, the result is a series. When the same system of operations is applied to elements regarded as both alike and different, the result is *number*. However, in contrast to the elements of classes and series, the elements of number are constructed by the child's own actions and are not given in immediate perception or in intuition.

E. CONCLUSION

This lengthy presentation of Piaget's thesis on the development of seriation and numeration fails to reflect the full depth and scope of his discussion. It is hoped, nevertheless, that the presentation will have made clear at least some of the complexities that underly such an apparently simple task as constructing a stairway or telling how many stairs a doll has climbed to reach a particular position. In attacking any conceptual problem, the child brings to bear a conceptual ability the form of which determines the nature of the particular conception he attempts to attain. Piaget has proposed that this conceptualizing ability derives from an internalization of the child's own actions upon objects and that, depending upon the contents to which they are applied, these internalized actions give rise to classes, relations, and numbers. The present study did not attempt to test Piaget's thesis regarding the development of conceptual ability, but did attempt to repeat those observations that Piaget has reported and on which he builds his thesis.

F. SUMMARY

Ninety children, 30 at each age level from 4 to 6-7, were tested for their ability to discriminate, seriate, and numerate size differences in one-, two-, and three-dimensional materials. Results show a regular increase with age in the child's ability and show that the dimensionality of materials affects the ease of success, but not the sequence of success, on discrimination, seriation, and numeration tasks. The results are in agreement with those secured by Piaget. In the discussion, an attempt was made to present Piaget's theory on the development of conceptual ability in general and on the development of the conceptions of a series and of a seriated class (number) in particular. The author concludes that Piaget's theory accounts not only for empirical findings, but also points up the psychological complexities and difficulties that underlie such apparently simple activities as constructing a stairway or determining how many stairs a doll has climbed to reach a particular stair.

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EFFECT OF ADRENALECTOMY ON FOOD, WATER, AND SALTWATER CONSUMPTION IN THE RAT: A METHODOLOGICAL STUDY*[1]

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A. Purpose

It is known that adrenalectomized rats show an increased preference for salt water (1, 4), that they consume more salt water than normal rats (2, 3), and that their survival is dependent on increased salt intake (7, 9). Little is known, however, about their food and water intake.

It is the purpose of this study to compare the food, water, and saltwater consumption of normal and adrenalectomized rats, and to suggest a saltwater consumption ratio that can serve as a criterion of adrenalectomy. Such a criterion is advantageous because rats with accessory cortical tissue or incomplete adrenalectomies may be discarded prior to experimentation.

B. Method

1. *Subjects*

Thirty naive, male hooded rats from the colony at the Carnegie Institute of Technology were used. All rats were between 90 and 100 days of age at the time of testing.

2. *Procedure*

Forty-eight hours before any measurements were taken, all rats were put into individual cages with cups of powdered food and two calibrated water bottles. One bottle contained distilled water, the other bottle contained a 3 per cent solution of salt water made with distilled water. After a period of acclimatization, the food, water, and salt water were available to the rat *ad lib* for 23 hours per day. Measurements were taken of the 23-hour consumption of all substances for five full days.

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On the sixth day, a total bilateral adrenalectomy was performed on 10 of the rats following the procedure described in Farris and Griffith (5) with ether as an anesthetic. A sham operation was performed on 10 rats; the other 10 rats remained undisturbed in their home cages. Immediately after the operation, rats were returned to single cages with food, water, and salt water available, and 23-hour consumption measurements were taken for the following five days.

At the end of the fifth postoperative day, the salt solution was withdrawn from all rats. Twenty-three hour food- and water-consumption measurements were taken for the next 20 days, or until the rat died.

C. Results and Discussion

One of the adrenalectomized rats died before the end of the five postoperative days; so the adrenalectomy results are based on an N of 9. Analyses of variance indicate that adrenalectomized rats maintained on salt solution consume less food than nonoperated control rats. F is 15.3, significant beyond the .001 level of confidence. Adrenalectomized rats consume significantly more salt solution. F is 69.6, significant beyond the .001 level. Adrenalectomized rats consumed less distilled water than did the control rats, but the difference was not statistically significant ($F = 2.46$). There were no differences between experimental and control groups in any of the consummatory measures during the five days of preoperative measures.

If *ad lib* consummatory behavior is an indicator of drive state, it is not legitimate to use hunger to motivate learning in adrenalectomized rats when comparing them with normal rats.

Adrenalectomized rats which are given no supplementary salt or adrenal-cortex extracts live for varying periods of time, depending on the strain and age of the rat. If the rat survives more than 30 days, histological examination generally has shown accessory cortical tissue (6). For those rats which die within the 30-day period, the mean survival time ranges from seven days to 17 days (6, 9). Thus if an adrenalectomized rat dies within 15 days of the withdrawal of salt, it may be assumed that the operation was complete.

Various investigators have reported that adrenalectomized rats increase their consumption of 3 per cent salt solution from five to six times (3, 9). Carr (2), however, observed increases from 1.4 to nine times. In order to set a preterminal criterion of adrenalectomy, the authors used a ratio determined by dividing the mean salt-solution consumption on the fourth and fifth postoperative days by the mean salt-solution consumption during the five days prior to the operation. In this experiment, the ratios ranged from 3.2 to 14.4 for the adrenalectomized rats and from zero to 2.5 for the control rats and the operated rats. The mean for the adrenalectomized rats was 10.8; for the control rats it was less than one. All adrenalectomized rats died within 17 days after the withdrawal of salt. Using 4.75 as a minimum acceptance ratio, the authors found that all adrenalectomized rats died within 15 days.

The same acceptance ratio was used in a more recent study (8), and all 15 adrenalectomized rats that met the criterion of 4.75 died within 15 days after salt was withdrawn.

D. SUMMARY

The 23-hour food, distilled-water, and 3 per cent saltwater consumption was measured for 30 hooded rats for five days. Then 10 rats were adrenalectomized, 10 were sham operated, and 10 were used as controls. Consummatory measures were taken for five days postoperatively. Adrenalectomized rats consume more salt water than do control rats, but less food and the same amount of distilled water; their total fluid intake is the same as that of the control rats. We conclude that hunger should not be used to motivate adrenalectomized rats if they are to be compared with normal rats. We further conclude that a saltwater-consumption ratio, determined by dividing the mean saltwater consumption on days 4 and 5 postoperatively by the mean saltwater consumption on the five preoperative days, can be used as a preterminal criterion of adrenalectomy. If the ratio reaches 4.75, the rat dies within 15 days after salt withdrawal.

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THE EFFECTS OF HANDLING AND SHOCKING IN INFANCY UPON ADULT BEHAVIOR IN THE ALBINO RAT*[1]

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A. INTRODUCTION

The experience of being handled and the experience of being shocked in infancy have been found to affect adult behavior in rats. Surprisingly, when the direction of the effects of two presumably different sorts of infantile experience are contrasted with the behavior of adult rats which have been kept in unmolested contact with their mothers, the experiences of "being handled" and "being shocked" appear to be similar rather than different in their effects. The purpose of the study reported here was to compare several forms of adult behavior in rats shocked and in rats handled during the second 10 days of life, and to compare this behavior with that of litter mates kept in unmolested contact with their mothers.

The observation that handling and shocking appear to produce similar effects on adult behavior derives from comparing the effects of infantile handling, as reported in studies by Weininger (17, 18), with the effects of infantile shock, as reported in studies by Levine (8, 9, 10, 11), Denenberg (3), and Lindholm (15). The observations also derive from the results reported by Levine, Chevalier, and Korchin (14). They reported similar effects for the two types of experience.

Compared with unhandled rats left in the nest with their mothers, adult rats which have been handled in infancy have been found to be more resistant physiologically to stress (12, 13), and to weigh more (12). Further, Levine (9) has found that disruption of drinking behavior after deprivation in adulthood is significantly reduced when handling has been experienced during

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infancy. Rats handled in infancy learn avoidance tasks better and show fewer signs of emotionality than unhandled rats (8).

Results of experiments in which infant rats are shocked and compared with nonshocked nest-control rats on various measures in later life provide striking similarity of results. In a study to assess the persistence of response as a function of thirst, drinking behavior of rats shocked in infancy has been found to be less disrupted emotionally in adulthood when drinking and shock are associated in infancy as well as when shock is associated only with drinking in adulthood (16). Levine (9, 10) and Lindholm (15) find less disruption of adult drinking after deprivation when early shock is not associated with drinking in infancy.

The similarity of effects from shocking and handling suggests a general developmental effect of such experiences. Bolstering this viewpoint are findings that infant shock and handling have similar effects upon organ development (12), upon the development of a normal stress response (11), upon open-field behavior (1).

Exceptions to the results just mentioned have appeared. As indices of emotional stability, measures of defecation and urination have not always supported the view that early handling results in a general stabilizing effect in later life (6), nor have results based on measures of learning and open-field behavior always supported this view (5). In a complex study in which many measures were used, Ader (1) found few behavioral measures that differentiated among several treatment groups, but groups that were handled, as well as groups that were given distributed emotion-provoking stimuli, were less emotional than control subjects in terms of position across tests. Contrary to earlier studies, physiological measures did not offer reliable evidence for differences among groups.

Within the perspective of findings contributed by dissimilar methodological approaches, it is questionable whether shocking and handling in the rat's infancy have similar effects. This is the problem to be investigated.

B. METHOD

Four groups of rats were subjected to differential treatment in infancy. In adulthood, the groups were compared on a variety of measures. These measures were drinking behavior, open-field activity, escape threshold for shock, and survival under stress. The purpose was to determine whether the infant shock experience and the infant handling experience produced similar effects.

1. *Procedure*

In the laboratory, which was kept as free as possible from extreme stimulation, a regular routine of care and experimentation was followed. To equalize extraneous stimulation, a single room served as colony and laboratory. Food and water were provided *ad lib*. Noise was minimized. Temperature, which could not be completely controlled, varied from 70° to 88° F. Due to problems of ventilation, some draftiness was encountered shortly after the birth of the second set of litters.

2. *Experimental Schedule*

The experimental schedule for each replication was as follows:

a. Day 1. Infant rats were born.

b. Day 2. Sociological litters were formed and assigned to infant conditions. Each new litter, composed of a mother and one of her pups together with three pups from other litters, was randomly assigned to one of four categories: N (nest controls), P (picked-up), H (handled), S (shocked).

c. Days 3 to 9. The rats were left in their living cages.

d. Day 10. The rat pups were weighed and returned to the cages and their mothers.

e. Day 11. Rats in Group S received shock for three minutes daily. The shock was adjusted to a level that kept the pups moving and squealing. Pups which comprised Group H were placed in the shock apparatus with no shock, but were handled by systematic stroking for three minutes per day; each rat received approximately 40 to 50 strokes per minute. Pups in Group P were merely picked up and placed in the apparatus for three minutes. No shock was administered. Rats in Group N were left continuously in the nest.

f. Day 21. Rats were separated from their mothers and individually caged.

g. Day 35. Rats were weighed and rated for resistance to being picked up.

h. Day 49. The amount of water consumed during the previous 24-hour period was recorded and a 24-hour deprivation period was initiated.

i. Day 50. Calibrated water tubes were presented through a cheesecloth ceiling and through the front of the cage. The room was darkened; only the light from the cage lights was present. Thus, much extraneous stimulation was eliminated, but the rats could be observed clearly and they could not see through the lighted cheesecloth. Latency of approach to the water tube was recorded, and the amount of water consumed during each two minutes of the 10-minute drinking period was recorded.

j. Day 55. Individually, rats were placed in the open field in the lower left-hand corner. The rats were always placed in the same position behind a masonite restrainer that contained the rat in the square. The restrainer was lifted and the number of squares traversed in the next three minutes was recorded. The right hind foot was darkened with ink to facilitate observation. The only squares counted were those entered by the darkened foot.

k. Day 60. Rats were tested for escape threshold in the shuttle box. A shock that lasted 4.9 seconds, with an intervening nonshock period of 6.1 seconds, was used. Each rat was placed individually into the apparatus, on the right side facing away from the shuttle. The first shock was delivered at a strength of .10 milliampere. If the rat did not leave the shocked side of the grid, the next shock was delivered at .20 ma, and the strength of the shock in each succeeding period was increased by .10 ma up to a maximum of .80 ma. The procedure was repeated until each rat left the grid five times. The intensity of shock necessary to activate a rat to leave the charged side of the grid was recorded in tenths of a milliampere for each trial.

l. Day 81. A battery jar was filled with water at a temperature of 20° C. The rat was placed in the jar, and a bell jar was inserted into the battery jar. The rat could swim in the water and breathe in the air space at the top of the bell jar. A continuous water supply insured the maintenance of constant water temperature. Swimming time was measured by noting the difference between time of placement in the water and the time when the rat's lungs became filled with water. The latter event is recognizable by a distinctive movement pattern that is subject to little error in judgment. A final measure, an afterthought, was weight taken after drowning. Each rat was tested individually, although three or four battery jars were used at the same time.

3. *Subjects*

Subjects were 75 Holtzman Sprague-Dawley rats. Originally, they were planned to come from two sets of 12 litters, each set of litters being born within a 48-hour period. Each litter was reduced to four male pups. To minimize genetic and social differences (7), a technique was used in which one pup was drawn from each of four biological litters. Pups were combined into a new social litter of four rats, one from the biological mother and one from each of three additional mothers. New litters were formed in the same way from other biological litters within each set of litters. Two replications were planned to avoid the difficulties of attempting to use at one time more rats than seemed feasible. Because of losses due to pneumonia in the first and the second sets of litters, additional rats to comprise a third replication were added. After losses, the first replication included 36 rats; the second and third replications included 19 and 20 rats, respectively.

4. *Apparatus*

a. Early treatment apparatus. The shock apparatus for the infantile experience condition was that used by Lindholm (15). It consisted of several nine-inch cubical compartments in which shock of variable intensity could be presented through a grid floor of thin metal rods.

b. Apparatus for adult caging and tests. The living cages for the adult rats were wooden cages, five to a row and four rows to a rack. The inside dimensions of the cages were 7-1/2 inches wide, 10 inches long, and 10 inches high. The sides and backs of the cages were wood. A sliding metal door was in the back of each cage. The top, front, and bottom of each cage were of hardware cloth. Each cage was illuminated from day 40 through day 50 with an individual light bulb. The fronts and tops of the cages were covered with cheesecloth to prevent the rats from seeing the observer. Six-watt, 120-volt bulbs were used and equated by a Variac (for 1.08 foot candles at 78 volts as measured by the MacBeth illuminometer) with three-watt, 120-volt bulbs at 115 volts.

Apparatus for the drinking test consisted of test tubes (25-ml capacity) with stainless-steel drink spouts, of stop watches, and of a wooden bar with broom clips to hold the test tubes when they were inserted in the cage.

The open field was a white plywood square that contained five nine-inch squares on a side. It was enclosed by masonite sides which were 23-1/2 inches high.

Apparatus for the escape-threshold test consisted of a shuttle box constructed after Griffiths (4). It was 7-1/4 inches wide, 12 inches high, and 36 inches long. It had grid floor bars placed 1/2 inch apart. The shuttle was 4-3/8 inches high, and was placed 18-3/4 inches from the left side of the box. The shock source consisted of a 240-volt transformer and a voltage divider circuit with a 50-megohm potentiometer that was calibrated in tenths of a milliampere over a 200,000-ohm load.

Apparatus for the swimming test consisted of a battery jar 9 inches in diameter and 12 inches high, and a bell jar 6-1/2 inches in diameter and 12-1/2 inches high. The bell jar was balanced on three ordinary water glasses inside the battery jar. When the battery jar was completely filled with water, an air space 4-1/4 inches high remained in the top of the bell jar, where the rat, by swimming, could breathe.

C. RESULTS AND DISCUSSION

The basic question investigated was whether infant shocking and handling have similar effects upon adult behavior, but first we must note that the effects of pneumonia in the colony were not the same for all groups. More nest-control rats died than did rats in other groups. In other groups, more rats suffered pneumonia but more recovered. Because of losses due to pneumonia, a change in statistical analysis was necessary. This change reduced the degrees of freedom from 75 to 26 and reduced the probability of obtaining significant results for a given amount of variance among the groups. The basic data, litter means, were subjected to analysis of variance, method of least squares.

The most significant finding is that a rat's behavior on the drinking test differs radically from that reported by Levine (9, 10) and by Lindholm (15), the latter of whom found latencies of 12 and 155.3 seconds for shock and nest groups, respectively. Levine assumes that a deprivation-induced disruption of a rat's water-seeking activities can be measured by the drinking test. However, when a rat is shielded from the sight of an observer, differences in latency and in amount of water consumed do not appear (see Table 1).

TABLE 1
LATENCY OF APPROACHING WATER TUBES AND AMOUNT DRUNK AFTER DEPRIVATION FOR VARIOUS GROUPS

A. Mean latency of approach in seconds

Nest	Picked-up	Handled	Shocked
2.95	1.99	3.84	1.45

B. Analysis of variance for latency of approach to water tube after deprivation

Source	Sum of squares	*df*	Mean square	*F*
Replications	8,480	2	4,240.00	1.749
Treatments	24,855	3	8,285.00	3.417
Interaction	14,549	6	2,424.83	.446
Error	76,138	14	5,438.43	
Total	124,022	25		

C. Means of amount of water drunk during drinking test

Nest	Picked-up	Handled	Shocked
9.15	8.85	9.11	8.62

D. Analysis of variance for amount drunk

Source	Sum of squares	*df*	Mean square	*F*
Replications	8,311.68	2	4,155.84	7.238*
Treatments	521.86	3	173.95	.303
Interaction	3,445.20	6	574.20	.774
Error	10,383.58	14	741.68	
Total	22,662.32	25		

* $p < .05$.

If, in previous studies, measures of a rat's tendency to seek water have been contaminated by the rat's responses to an observer, re-examination of previous findings is in order.

In the study reported in this paper, five independent measures of adult behavior were used. These measures were (*a*) resistance to being picked up, (*b*) drinking behavior, (*c*) activity in open field, (*d*) escape threshold, and (*e*) survival time.

For resistance to being picked up, variance among groups approached but did not attain significance at the .05 level ($F = 4.05$; $df = 3, 6$). On resistance to being picked up, shocked rats and handled rats differed from nest-control rats in the same direction. If resistance to being picked up is an index of emotionality in adulthood, our data are consistent with Levine's hypothesis that shocking and handling during infancy reduce emotionality in adult rats (see Table 2).

TABLE 2

MEANS AND SUMMARY OF ANALYSIS FOR DATA ON RESISTANCE TO BEING PICKED-UP

A. Means for being picked-up

Nest	Picked-up	Handled	Shocked
3.00	1.13	1.73	1.37

B. Analysis of variance

Source	Sum of squares	*df*	Mean square	*F*
Replications	39,174	2	19,587.00	1.041
Treatments	228,782	3	76,260.67	4.054*
Interaction	113,285	6	18,808.33	1.424
Error	184,812	14	13,200.86	
Total	566,053	25		

* $p < .05$ when $F = 4.35$.

As the issue of direction of differences between shocked and handled rats is of major concern, two methods were used to clarify outcomes with respect to this issue.

First, since the behavior of the nest-control group reduced variability among groups, it may be that the overall test of significance failed to reveal treatment differences that a comparison of the shocked group with the handled group would reveal. In each of five cases for which differences were expected, the difference between the shocked and the handled groups was computed and compared with its interaction variance from the original analysis. In three of the five cases, differences in direction did occur.

Second, heterogeneity of correlation indicates that treatment groups were not affected by the treatments in the same way. Within-groups, correlations of pairs of measures were examined to obtain information about the direction of effects. In the case of escape-threshold average and activity in the open field, there was heterogeneity of correlation. Furthermore, the correlations for shocked and handled groups were significant and were opposite in direction. Because this particular analysis was *ex post facto,* the results should be viewed as suggestive rather than definitive.

While mean differences for each of the measures are small from group to group, within-groups correlations are substantial.

On resistance to being picked up and activity in the open field, one would expect that rats handled and rats picked up would differ in the same direction from shocked rats, but they do not. Table 3 presents five pairs of inter-correlations for comparison with correlations across groups. From Table 3 it is clear that correlations of measures across groups obscure important differences between groups.

TABLE 3

COMPARISON OF ACROSS-GROUPS AND WITHIN-GROUPS CORRELATIONS

Measures	Correlations across-groups	Within-groups correlations Nest	Pick-up	Handled	Shocked
Escape threshold and open-field activity	—.082	—.291	—.148	.488*	—.473*
Resistance to pick-up and latency	.171	.086	.337	.263	—.240
Resistance to pick-up and open-field activity	.069	—.311	—.040	.540*	—.035
Open-field activity and amount drunk	.160	—.235	.253	—.400	.350
Escape-threshold and 35-day weight	.038	—.034	.052	—.199	.271

* Significant correlation, $p < .05$.

The picture of the handled rat that emerges from this study is not like that obtained by Levine (8, 9, 10, 11) or by Levine and Otis (13). Rats that Levine handled during their first 10 days of life showed greater precocity and survived stress better than nest-controls. Rats handled in the present study did not (*a*) show greater precocity (weight measures), or (*b*) survive stress better (survival test), or (*c*) approach drinking tubes more quickly, or (*d*) drink more water. Rats that were handled appeared more stable than nest-control rats only in the case of being less resistant to being picked up, an experience they had had in infancy. It is not clear whether the rats handled failed to be more stable than nest-control rats because of the effects of pneumonia, or whether handling in infancy failed to affect adult behavior.

The question of whether the effects of shock and handling are different or the same cannot be answered with certainty from our data. If pneumonia is a stressful experience, it is likely that all the manipulated groups of rats experienced a high level of infant stress. If so, such stress could have obscured differences due to the effects (if any) of the various treatments.

In addition to the evidence on the effects of shock and handling, two findings are of methodological importance. First, the drinking test, as employed by earlier investigators, is probably a contaminated measure. Second, correlations of pairs of variables within groups provides information that may be used in constructing a composite picture of the rat's behavior in new situations. From such a composite picture, it should be possible to predict a rat's behavior in new situations. Correlations within groups should also make it possible for an investigator to determine the usefulness of various measures. Correlations across groups tend to obscure differences of primary interest: namely, those due to experimental treatment.

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EARLY EXPERIENCE AND LSD-25*

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A. INTRODUCTION

The purpose of this study was to determine the influence of variations in infantile experience on the behavioral effects of LSD-25 in adult rats. Bovard (4) has reported that handling rat pups during infancy modifies the balance of hypothalamic activity in favor of the anterior (parasympathetic) regions. Such modification reduces adult pituitary-adrenal and sympathetic-adrenal medulla responses to stress. Hence, handling is judged to reduce emotional reactivity to stress. Conversely, leaving rat pups to develop unmolested in the maternal nest appears to maximize sensitivity to external stimuli. According to Purpura (13), LSD-25 decreases reactivity of the nonspecific afferent system in cats. Hence, presumably, LSD-25 reduces an organism's emotional responsiveness to stress.

The possibility that variations in infantile experience may influence effects of LSD-25 was suggested by some research on schizophrenia. Clinical observers claim that schizophrenes commonly are reared in an overprotective and restrictive manner (2, 3, 5, 11). Others have alluded to the presence in schizophrenes of a psychotogenic agent, such as LSD-25 (1, pp. 91-119; 8, pp. 120-145). LSD-25 is related structurally to some of the breakdown products of epinephrine found in humans (7). Winter and Flataker (16) have added credibility to the notion that a psychotogenic agent exists. They have demonstrated that serum from the blood of psychotic patients (largely schizophrenic) and LSD-25 have similar effects on the behavior of rats. If *both* early experience and psychotogenic agent are involved in the development of schizophrenia, the nature of the interaction effect between these variables would be of heuristic interest.

B. METHOD

1. *Subjects and Procedure*

Litters of rats were randomly split to form sociological litters. The pups in one set of sociological litters were handled in infancy; pups in the other

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set were left in the nest unmolested or ignored. Testing began when the rats were 53 days old, on which day the groups handled and ignored were further subdivided. Half of the rats in each group were given injections of LSD-25; the other half were given "dummy" injections. Rats were then tested for general activity, water consumption, and avoidance learning.

Forty Holtzmann albino rats were used as subjects. They were raised from infancy by the experimenter and were housed in a research room in which an electric motor produced a constant background sound. The racks of cages were completely surrounded by a homogeneous field of white cloth curtains. A single ceiling lamp (three feet to the side of the cages) was allowed to burn eight hours per day. Light distribution was equalized (somewhat) by placing sheet metal over the top row of cages.

Two days after the birth of the rats, the natural litters were distributed among all the mothers in order to equalize genetic factors in the experimental and control groups. The litters were then randomly designated as "gentled" (i.e., handled) or "ignored."

Treatment was begun at once; i.e., on the second day. When pups were to be handled, the mother was removed from the home cage and was placed in a carrying cage. At first, three pups at a time were stroked from head to tail (at the rate of about 50 strokes per minute) for three minutes per day. When the rats were larger, each rat was handled individually. After the rats had been handled, they were replaced in the cage and, after a complete litter had been handled, the mother was returned to the cage. Handling or "gentling" was continued past weaning until the rats were 40 days old. At that point, experimental handling was discontinued until the 53rd day, when testing was begun.

Control rats (i.e., the rats ignored) were handled only for cage rearrangement and weaning. Treatment and housing were identical for all rats.

On the 21st day after birth, the rats were weaned, marked, and weighed. Within treatment groups, they were then assigned to smaller, separate cages, two rats to a cage. Cage mates were of the same sex. Solid, sheet-metal cage dividers separated the animal pairs.

2. *Apparatus*

Three sets of apparatus were used. The first set consisted of a tabletop, 60 × 30 inches, covered by a sheet of light gray wallboard. Fifty squares, 6 × 6 inches, were marked on the wallboard with a china marking pencil. The table was surrounded by black curtains situated one foot from its edges and was placed directly beneath the overhead light in the room previously described.

On a similarly enclosed table nearby was a cage to which an eudiometer tube (100 cc capacity) filled with tap water was attached.

The third set of apparatus was located in a room directly adjacent to the research room. It consisted of a black runway 39 inches long, 5-1/2 inches wide, and 4 inches deep. A black starting box 8-1/2 inches long and a white goal box 11 inches long were closed off from the main runway by guillotine doors. Both starting box and runway floors consisted of electrified grids. The apparatus was capable of providing an electric charge based on 115 volts passed through a resistor of 150,000 ohms.

3. *Testing*

Testing began on Day 53 and continued for 10 days. On each day, two rats from the group of handled or "gentled" rats and two rats from the "ignored" group were randomly selected from one sex. Thus, on any given test day, all rats tested were males or all were females. One of the two "gentled" rats was assigned to an LSD group and one was assigned to a "distilled water" group. The "ignored" rats were similarly assigned. Prior to testing, each rat was deprived of food and water for 48 hours.

a. Group G-LSD. This group consisted of "gentled" rats. After weighing on the test day, each rat in this group was given an intraperitoneal injection of LSD-25. The dosage was 0.5 milligram of LSD per kilogram of body weight (i.e., 2 ml of an aqueous solution of LSD-25 per kilogram of body weight).

b. Group G-H_2O. This group consisted of "gentled" rats which were treated with an injection of 2 ml of distilled water per kilogram of body weight.

c. Group I-LSD. This group consisted of "ignored" rats treated with LSD-25.

d. Group I-H_2O. This group consisted of "ignored" rats treated with distilled water.

The four rats employed each day were tested in systematic order. (*a*) Thirty seconds after injection, the rat was placed on the tabletop and the number of squares the animal traversed was recorded for each of 20 consecutive minutes. A square was counted if the rat's left hind foot was placed in it. (*b*) The animal was placed in a carrying cage for two minutes. (*c*) He was placed for 20 minutes in the cage containing the eudiometer tube, and a record of the amount of water consumed was obtained. (*d*) The rat was allowed to rest one minute. (*e*) Then the rat was given 20 trials in the runway. Fifteen seconds after the rat was placed in the starting box, the guillotine door was raised. Such action simultaneously activated a buzzer, the shock stimulus, and a chronograph. When the animal crossed the threshold of the goal box, the guillotine door was lowered (stopping buzzer, shock, and chronograph). The rat was permitted to remain in the goal box for 30 seconds, after which the next trial was begun. For trials 4 through 20, the shock grid was not electrified; only the buzzer and the chronograph were operative. The time recorded on the chronograph for the 17 nonshock trials constituted the third measure employed in this study.

C. RESULTS

The general findings show (*a*) no significant weight differences between handled and ignored groups; (*b*) a significant interaction effect between LSD-25 and early experience during the initial stage of tabletop activity; and (*c*) a trend, on the part of "ignored" animals given LSD-25, toward greater running speed in the avoidance task.

Table 1 summarizes the weight data. A series of Kruskal-Wallis H tests (14) was performed to determine whether there were significant differences among the groups in weight *after deprivation* (immediately prior to testing). Separate tests were performed on the weights for the four males in each group, on those for the six females in each group, and on the weights for each of the four groups. A final Mann-Whitney U test (14) was done on these same weight data considering all 20 gentled animals as one group (regardless of type of injection) and all 20 ignored animals as one group (again disregarding injection). A U test performed on weight measures four days before the start of testing (with the animals satiated) revealed no significant differences between the gentled and the ignored animals; at that point the means were 183.1 and 183.3 respectively.

TABLE 1
MEAN WEIGHTS OF GROUPS AFTER DEPRIVATION

Group	Males ($N = 16$)	Females ($N = 24$)	Males and Females ($N = 40$)
G-LSD	194.55	151.68	168.83
G-H_2O	201.25	146.83	168.60
Total			168.72
I-LSD	194.40	156.07	171.30
I-H_2O	201.32	159.70	176.35
Total			173.83

1. *Activity Measure*

The highly significant interaction effect shown in Table 2 confirms the hypothesis that the effects of LSD-25 on the activity of animals are significantly altered by variations in early experience.

Barlett's test (12) showed that the hypothesis of homogeneity of variance was tenable for the tabletop activity data. An analysis of variance, using the factorial design model discussed by Lindquist, was therefore applied to the untransformed data. The F for between-groups variance proved to be significant beyond the .01 level of significance. The mean number of boxes traversed by each animal in each of the groups during the 20 minutes of tabletop activity was as follows: G-LSD, 115.2; I-LSD, 209.9; G-H_2O, 272.4; I-H_2O, 218.7. Table 2 shows the partitioning of the between-groups sum of squares.

TABLE 2
PARTITIONING OF BETWEEN-GROUPS SUM OF SQUARES FOR TABLETOP ACTIVITY (20 MINUTES)

Source of variation	Sum of squares	*df*	Means squares	*F*
Early experience (G *vs.* I)	2059.2	1	2059.2	.4
Chemical (LSD *vs.* H_2O)	82355.7	1	82355.7	16.8**
Interaction	53655.6	1	53655.6	10.9**
Within groups	176776.3	36	4910.5	

** Significant at .01 level.

Lindquist's method of testing the differences between particular pairs of means, after an analysis of variance procedure, reveals that four of the six possible pairings are significant; the two comparisons yielding *insignificant* *t*'s are those performed between groups I-LSD and I-H_2O and between groups G-H_2O and I-H_2O. Figure 1 shows the tabletop activity curves of the four groups over the 20-minute period. It is of special interest that the gentled and the ignored groups given dummy injections (groups G-H_2O and I-H_2O) present similar curves of activity which are not significantly different from one another, while comparable groups (G-LSD and I-LSD) given LSD-25 yield curves significantly different from one another. LSD-25 did not appear simply to have exaggerated subtle differences between gentled and ignored animals, because the slopes of the pertinent curves are not similar and, in addition, there is the reversal in activity measures of gentled and ignored groups depending on whether they have been given LSD or not. Although the total number of boxes traversed by the two ignored groups during the

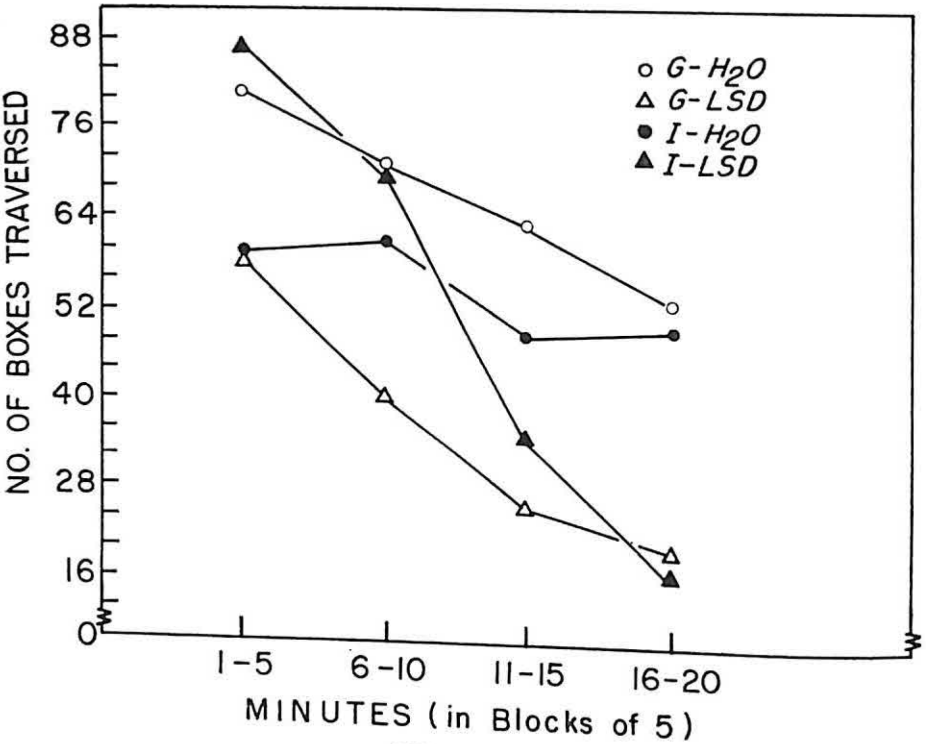

FIGURE 1
NUMBER OF BOXES TRAVERSED AS A FUNCTION OF TIME AFTER INJECTION AND SUBSTANCE INJECTED

20-minute period is not significantly different, the slopes of the curves produced by these groups are highly divergent, group I-LSD's range being the largest of the groups and group I-H_2O's being the smallest.

Two additional analyses of variance were performed on the tabletop activity data. The first analysis included only the data for the first 10-minute period, while the second included only the data for the second 10-minute period (see Table 3). As the data show, the interaction effect is maintained only during the first stages of LSD-25 intoxication and dissipates as the drug effect becomes maximal. The mean numbers of boxes traversed for the first and the second 10 minutes of tabletop activity (respectively) are as follows: G-LSD, 86.1, 29.1; I-LSD, 158.7, 51.1; G-H_2O, 148.0, 124.4; I-H_2O, 120.7, 98.0.

2. *Water-Consumption Measure*

The analysis of variance on the transformed drinking measures showed significance (at the .01 level) only for the main effect due to type of chemical

TABLE 3
PARTITIONING OF BETWEEN-GROUPS SUMS OF SQUARES FOR
FIRST AND SECOND PERIODS OF TABLETOP ACTIVITY

Source of variation	Minutes 1-10 Sums of squares	*df*	Means squares	*F*	Minutes 11-20 Sums of squares	*df*	Means squares	*F*
Early experience (G *vs.* I)	5130	1	5130	2.1	60	1	60	0
Chemical (LSD *vs.* H_2O)	1428	1	1428	.5	50197	1	50197	9.8
Interaction	24950	1	24950	10.1**	5736	1	5736	1.1
Within groups	89141	36	2476	—	185331	36	5148	—

** Significant at .01 level.

(water or LSD-25) used (see Table 4). Because Bartlett's test indicated that homogeneity of variance was not tenable for the data on water consumption, a log transformation that corrected for heterogeneity of variance was employed. Correcting the water-intake measures for body-weight differences did not notably affect the analysis. Neither the early experience nor the interaction effects were significant. The mean number of cubic centimeters of water drunk by each animal during the 20-minute period in the water cage for the four groups was as follows: G-LSD, .54; I-LSD, .37; I-H_2O, 2.72; G-H_2O, 2.36. As is patent, LSD-25 inhibited water consumption in the rats regardless of type of early experience. The water-drinking period (from the 20th to the 40th minute after LSD injection) occurred at the height of LSD intoxication when the animals were virtually immobile. Differential results as between gentled and ignored animals may have been found with a smaller dose of LSD-25. The hypotonic distilled-water injection did not appear to mask differences among groups.

TABLE 4
PARTITIONING OF BETWEEN-GROUPS SUMS OF SQUARES FOR
WATER DRINKING (MINUTES 20 THROUGH 40 AFTER INJECTION)

Source of variation	Sums of squares	*df*	Means squares	*F*
Early experience	.00	1	.00	0
Chemical (LSD *vs.* H_2O)	1.43	1	1.43	51.52**
Interaction	.02	1	.02	.70
Within groups	1.00	36	.03	—

** Significant at .01 level.

3. *Runway Measures*

The analysis of variance did not yield significance at the .05 level. The obtained F was 2.75, while the F required for significance was 2.86. However, the data emphasize the trend for ignored animals which are given LSD to be fastest. The other three groups yield results that are highly similar to one another. The trend toward greater speed among the I-LSD subjects parallels their heightened motility during the initial phase of tabletop activity. Heterogeneity of variance is significant for speed of running scores. A log transformation to correct for heterogeneity was applied and an analysis of variance was performed, the score for each animal being the mean of the 17 nonshock trials in the runway. The mean running times (in hundredths of a second) for the groups were as follows: G-LSD, 31.04; I-LSD, 23.84; I-H_2O, 29.23; G-H_2O, 31.87. These measures were obtained during the 20-minute period starting at 40 minutes after injection. During this time, LSD intoxication had passed its peak.

D. Discussion

The discrepancy in behavior between gentled and ignored animals at the initial and the terminal stages of LSD-25 intoxication is an interesting one. Those rats which were gentled and given LSD-25 might be expected to be inured to novel or to noxious stimulation, and, presumably, therefore, to be relatively immobile and imperturbable. In the case of ignored rats given LSD-25, two conflicting effects would presumably be operative—ignoring serving to render these animals excitable and LSD-25 serving to render them insensitive.

In the case of the gentled animals given LSD-25, both agents, following from the views of Bovard (4) and Purpura (13), would serve to lessen excitability. Combining both the effects of early experience and LSD-25, we would expect ignored LSD animals to be more active than gentled LSD animals. The hyperactivity of ignored, LSD-25 injected rats (as compared with the gentled LSD-25 controls) appears to corroborate Bovard's view of the effects of early experience. The fact that the control groups (G-H_2O and I-H_2O) did not differ may highlight the "latent" nature of the effects of varying early experience, differences becoming evident only when a markedly novel stimulus (LSD-25) is introduced. The effects of differences in handling are nullified when the relatively large dose of LSD-25 reaches full potency. At that point (approximately 20 minutes following injection), all the animals given the drug are relatively immobilized. It is instructive to note that the behavioral effects of handling were evident under the initial and the terminal stages of LSD-25 intoxication despite the fact no weight differences were observed among groups prior to testing. Relating this to Bovard's ideas, it would appear that the sequelae of handling relating to "emotionality" do not covary with the anabolic or growth sequelae.

In regard to schizophrenia, our results highlight the notion that the toxic element hypothesized to be active in that disorder does not act *in vacuo*. Rather, the interaction between toxic agent and the experiential background of the individual must be studied. Speculatively, this interaction may determine which variety of schizophrenic symptoms the individual displays, or one might question, on the basis of the present results, whether the initial and the terminal stages of the disorder differ, behaviorally, in those schizophrenics with overprotective or restrictive parents as opposed to those where overprotection is not involved.

E. SUMMARY

The question of an interaction effect between early experience and LSD-25 was studied. It was found that a significant interaction effect occurs during the first 10 minutes after LSD-25 injection. Ignored rats injected with LSD-25 show significantly greater activity on a tabletop than do gentled rats injected with LSD-25, despite the fact that control groups not given LSD-25 are not significantly different from one another. The implications of these findings for Bovard's hypotheses concerning the later effects of "gentling" and "ignoring" organisms in infancy were considered. Speculations concerning the possible ramifications of these findings for the study of schizophrenia were also discussed.

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THE REACTIONS OF RHESUS MONKEYS TO FEAR-PROVOKING STIMULI* [1]

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A. PURPOSE

Several studies have demonstrated that rhesus monkeys housed in an enclosed box will repeatedly perform simple tasks for the opportunity to look outside (2). The readiness with which they do this depends, in large part, on what there is to watch. For example, monkeys will push open a door more frequently to see another monkey than to view, say, food or an empty chamber. There are situations, however, that can lead to a near suppression of viewing behavior. Such situations are those in which it is reasonable to infer that the *S*s are frightened. It is not uncommon, for instance, for young monkeys (when first confined to the test apparatus) to huddle in the corner of the box and refuse to push open the door to look outside. With further experience in the apparatus, nearly all monkeys readily respond to the door. In situations like this, it is assumed that the monkeys were fearful initially, but that they gradually adapted to the test apparatus and its environs. Under formal testing conditions it has been shown that monkeys will open a door merely to view an empty cage, but if a large dog is present in the cage, the monkeys' door-opening responses are suppressed (1). The inference, of course, is that the presence of the dog generated fear that suppressed visual exploratory behavior.

On the assumption that failure to view a stimulus object is an indication of fear when there is reason to believe that the object has fear-provoking properties, several selected stimulus objects were used to find out whether they provoked fear in the rhesus monkey. Some of the stimulus objects used in the first group of experiments were similar to those employed by Hebb (3) when he studied fear in chimpanzees. Among other objects, he exposed his animals to a deeply anesthetized chimpanzee, a human skull, and an adult

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ape head. All of these stimulus objects elicited vigorous withdrawal. In some cases, this withdrawal bordered on panic.

In interpreting his results, Hebb favored the concept of spontaneous fears; i.e., an innate susceptibility to fear certain kinds of stimuli. This is an interesting idea and one wonders whether other subhuman primates might exhibit fear under comparable circumstances. In the present study, the author also tested the notion that a view of a frightened monkey will provoke fear in an observing monkey (5).

In the author's second group of experiments, the test situation was changed so that a known fear-provoking stimulus (live snake) was *inside* the test box with the monkey. The box was completely dark, but the monkeys could turn on a light by pulling a chain. The question was, "Would they?" This question is relevant to the concept that fear can be an energizer as well as a suppressor of behavior. For purposes of exposition, the method and the results for Group I and Group II experiments will be described separately.

B. Method and Results

1. *Group I Experiments*

A total of 10 monkeys participated in the experiments, but not all served as *S*s for each experimental condition. The animals were placed in an enclosed box, two feet wide, two feet long, and two feet high. The box contained two transparent Lucite windows, three inches wide and one-half inch high. The windows were located opposite one another on the walls of the box. Another box, the dimensions of which were the same as the box that housed the test animals, stood two feet in front of each window. The boxes had a transparent plastic front and held the stimulus objects. The test box and the boxes with the stimulus objects were located in a sound-deadened room.

As the room was lightproof, *S* could not see anything outside the test box; however, each box that held a stimulus object had a 150-watt lamp fixed to its top. *S* could cause a particular stimulus-object box to be illuminated by positioning his head close to the window that faced that box. The agencies that made such a result possible were exciter lamps and photomultipliers located in the immediate vicinity of each window.

When the monkey looked out of a window, a photomultiplier increased the positive voltage delivered to an amplifier tube, and the amplifier tube activated a relay. The relay closed a circuit, and the box with the stimulus object was illuminated. The lamp remained on for as long as the animal kept its face within one and one-half inches from the window. As soon as the animal withdrew his head, the circuit was broken and the lamp in the stimulus-object box went out. The number of times that a monkey went to each window, as well as the length of time he remained there, was recorded automatically on impulse counters and on running-time meters located in an adjacent room. Data for each window were registered separately.

a. Condition No. 1. Four adolescent monkeys were tested for two days, 10 minutes a day, in a situation in which each stimulus-object box contained another adolescent monkey. The frequency of viewing responses and the total viewing time were recorded. On the third test day, one of the monkeys housed in the stimulus-object box was given a general anesthetic prior to the tests. The animal was placed in the box while unconscious. The four *S*s spent less time viewing this monkey when he was anesthetized than when he was not anesthetized, but suppression of viewing responses, which would have been expected had *S*s been extremely frightened, did not occur. The mean numbers of responses to the anesthetized animal were 47.5, 42.0, and 23.2 for Day 1 through Day 3, respectively. The mean lengths of time spent viewing the anesthetized animal were 2.00 minutes for Day 1, 1.96 minutes for Day 2, and 0.47 minute for Day 3. Toward the unanesthetized monkey, viewing behavior on Day 3 differed little from that of the previous days.

b. Condition No. 2. A similar situation was established with a normal monkey as one stimulus object and a headless, perfused monkey as the other stimulus. The head of the second monkey was placed in its own outstretched hands. (Incidentally, this animal had been sacrificed just prior to the test so that it could be examined histologically and the extent of a brain lesion could be determined.) Ten monkeys were given a 10-minute test session in which they could view the normal and the perfused animals. The dismembered monkey elicited more viewing behavior from the four *S*s than did the live and active monkey. Mean viewing time for the entire group, however, was less for the perfused monkey than for the live and active monkey (1.06 minutes versus 1.43 minutes). Also, fewer viewing responses were made to the dismembered monkey than to the normal monkey (26.7 versus 45.7). The main point, however, is that viewing behavior was not suppressed by the sight of a headless member of the species.

c. Condition No. 3. The *S*s could view either of two monkeys depending on which window was approached. Eight monkeys were given two control five-minute tests and the viewing behavior at each window was recorded. The *S*s looked at one monkey about as much as they looked at the other. On the third test, three live garter snakes were placed in the box with one of the stimulus monkeys. This monkey, upon receiving the snakes in the box, showed overt signs of fear, such as gritting teeth and standing motionless in one corner of the box, and then jumping quickly to the opposite corner. No vocalization, however, was heard. It is unlikely that the *S*s saw the snakes because the lower one-third of the front of the stimulus-object box was covered with a sheet of Masonite during these particular test sessions. The front of the other stimulus box was blocked off in the same way.

During this experimental test, the *S*s spent about the same amount of time viewing each monkey. Total viewing time for the session differed little from that recorded on each of the control tests. Assuming that fear suppresses viewing behavior, the results suggest that a view of a frightened monkey does not provoke fear in an observing monkey.

d. Condition No. 4. The tests just described were repeated under different circumstances. Only one window in the test box was available for viewing events that happened outside the box, the other window being replaced by a metal plate. When looking out of the window, the *S* could see an empty box, three snakes in the box, another monkey in the box, or both the snakes and the monkey in the box. The stimulus monkey was the monkey that seemingly showed the most fear of snakes during a screening test in which several monkeys were confined, one by one, to the box with the snakes. Nine monkeys were used as *S*s, and the order of stimulus conditions followed a Latin-square arrangement. Each monkey was given two six-minute tests under each stimulus condition.

The mean times per session that *S*s viewed the various stimulus conditions were 0.31 minute for the empty box, 0.27 minute for the snakes, 0.74 minute for the monkey, and 0.77 minute for the monkey and the snakes housed together. Differences between conditions were significant ($p < .05$) with the Friedman chi-square test. The stimulus monkey was undoubtedly frightened when confined with the snakes, but this did not greatly disturb the observing monkeys, as judged by their responses to the window. It is of interest that a view of the snakes alone did not suppress the *S*s' observing behavior. However, the results of one of the Group II experiments to be described in the next section show that observing behavior can be reduced dramatically by a view of snakes when the latter are in the immediate vicinity of the observation window.

With the possible exception of Condition No. 1 data, the results thus far have been negative; i.e., no stimulus condition served to suppress or markedly decrease viewing behavior. Stimulus conditions other than those described above were used. One, for example, consisted of an experimenter who was wrapped in a black cloth and wore a green mask over his face and large leather gloves on his hands. When a monkey in the test box first looked at this figure, the animal did not look again for several minutes. Yet, some animals soon overcome their "hesitancy" and, in fact, acted aggressively toward the disguised *E*. Because we did not wish to study at this time the monkey's adaptation to situations generating fear, another group of test conditions was established. Some of these conditions, with a minimum of adaptation, were expected to provoke fear throughout a series of daily test sessions.

2. *Group II Experiments*

For all but one of the Group II experiments, the *S*s were housed in an enclosed box, two feet long, two feet wide, and two feet high. The box was located in a sound-treated, light-proofed room. At the rear of the box, protected by a Plexiglass shield, was a 25-watt lamp that could be turned on by pulling a chain suspended from the top of the box. The lamp would stay on for only six seconds, but it could be turned on again if the *S* responded to the chain. The number of times that the monkey pulled the chain to illuminate the lamp was recorded automatically in an adjacent room. Responses to the chain that may have occurred when the lamp was already illuminated were not registered and did not influence the subsequent action of the lamp.

A total of 14 rhesus monkeys participated in this group of experiments. Six of the monkeys had been *S*s in the previous group of tests. As soon as the *S*s began to work "consistently" for light reinforcement—i.e., to pull the chain at least 10 times within 10 minutes for two successive days—formal testing was started. For each test session, the *S* was placed in the box with the light on. *E* left the room immediately and turned off the light via a switch in the next room. At that point, the test formally commenced.

a. Conditions A, B, C, and D. Condition A consisted of five daily 10-minute test sessions in which monkeys worked for light reinforcement. Responses to the chain were recorded each minute. Condition B differed from Condition A in that a garter snake, approximately 20 inches long, was placed in the box immediately following the entrance of *S* to the box. Again, five daily tests were given, and each test lasted 10 minutes. The data were recorded every minute. Condition C was a repeat of Condition A. In Condition D, the first two tests were the same as those given in Condition B; i.e., the monkey and the snake were together. Pulling the chain by the monkey turned on the lamp. On Days 3, 4, and 5, the snake was still with the monkey, but the box remained illuminated. When the *S* pulled the chain, the lamp would go out for six seconds. Test duration and recording arrangements were the same as those for the previous tests. Twelve monkeys experienced all conditions.

The results for Conditions A through D are shown in Figure 1 which, for each test session, shows median response frequency to the chain. The median response rates under Conditions A and C were reasonably consistent from day to day. Notwithstanding the fact that some *S*s showed a marked decrement in responsiveness during the first two test days, most responses were made to the chain during Condition B. A Friedman chi-square test was carried out on Conditions A, B, and C by using ranks based on median response rates. Differences in performances between conditions are significant beyond the .05 confidence level. Condition D data provided a check on the possibility that the increase in chain-pulling responses exhibited by most *S*s during Condition B was due to an increase in general activity (with pulling-the-chain being merely one of the behavioral components). However, since chain-pulling responses dropped precipitously when they led to turning off

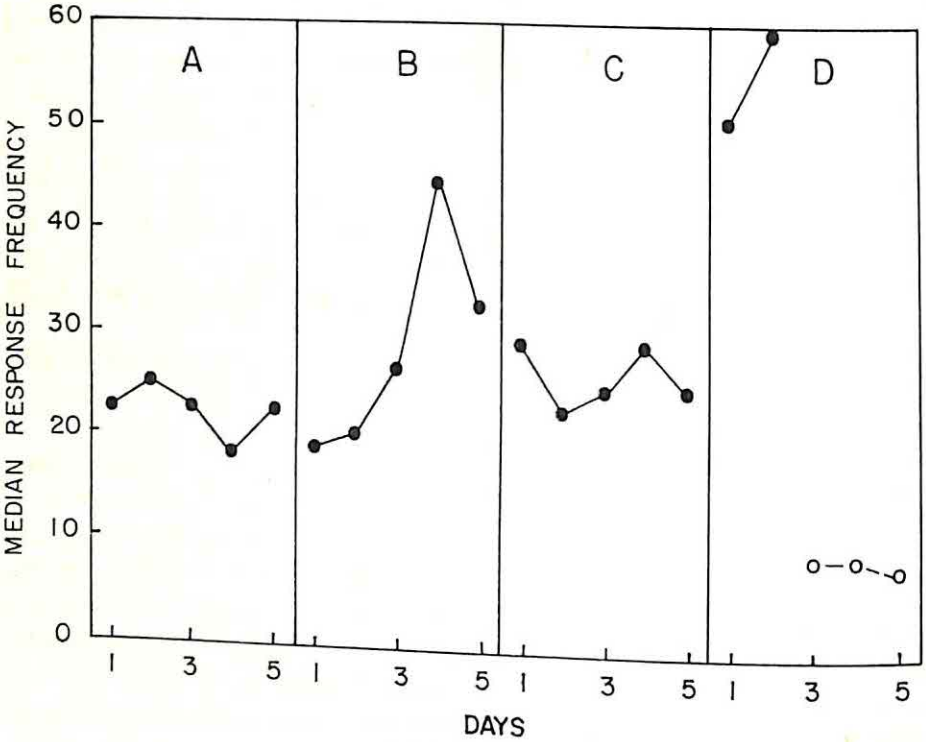

FIGURE 1
MEDIAN RESPONSE FREQUENCY FOR CONDITIONS A THROUGH D

the lamp (see Figure 1, open circles) the implication is that the *S*s' behavior during Condition B was directed toward keeping the box illuminated.

b. Condition E. This test situation was similar to Condition B, with its rationale being based on some of the data secured under Condition B. Specifically, two *S*s showed a response decrement through the five test sessions in Condition B. Conceivably, these *S*s were frightened to such an extent that they could not function in the apparatus. In the present tests, auditory stimuli were added to the emotionally charged situation. Fourteen monkeys served as *S*s, and two 10-minute tests were given. When a test had been in progress for three minutes, recorded sounds were played for 15 seconds through a speaker that was located near the test box. One class of sounds consisted of recorded alarm cries emitted by rhesus monkeys. The other class consisted of interrupted random noise. Both classes of stimuli were presented at a high-intensity level estimated to range from 75 to 90 db above the threshold for a normal-hearing person. On Day 1, half of the *S*s heard the alarm cries and the other half heard the noise. The presentation was reversed on the second test day.

Figure 2 shows the cumulative median response frequency to the chain during the 10-minute tests. The curve labeled "control" was based on the median chain-pulling performance on previous tests (Days 1 and 2 of Condition D). Both auditory stimuli served to decrease responses to the chain, but the effect was clearly greater when the alarm cries were presented.

c. Condition F. During these tests, the lamp was moved to the side of the box and placed on the top of a plastic box which itself was secured to the test box. The plastic box was four inches wide at one end and six inches wide at the other. It was eight inches long and three inches high. The smaller end was attached to the test box, but a sheet of screening separated the two boxes. Five daily tests were given to 10 monkeys, with responses to the chain leading to light-reinforcement. On Days 1 and 2, the plastic box was empty, but on Days 3, 4, and 5, it contained a small snake. Median response frequencies to the chain were 31.5, 32.0, 25.5, 28.5, and 32.2 for Days 1 through 5 respectively. When the snake was first placed in the plastic box (Day 3) some *S*s responded less frequently, but the decrement was not dramatic.

d. Condition G. The test apparatus was that employed in the Group I experiments, but only one window was available for viewing. In the present series of tests, the monkey, in going to the window, would cause a lamp to light in the stimulus-object box, which box housed a second monkey. *S*s were forced to view the second monkey through the plastic box just described. The plastic box was fixed to the outside border of the window of the test box. A

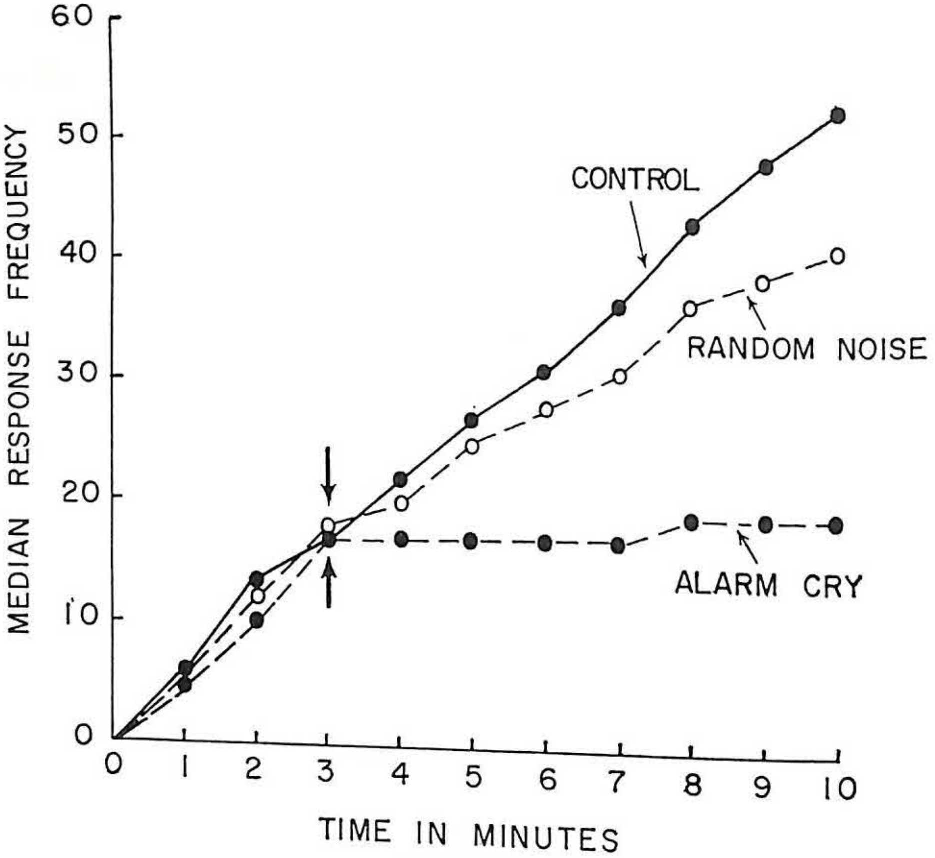

FIGURE 2
CUMULATIVE MEDIAN RESPONSE FREQUENCY AS A FUNCTION OF MINUTES
(The arrows denote when the recorded sounds were presented)

screened partition was interposed between the plastic box and the test box. Twelve *S*s participated. Five daily 10-minute tests were given, and total time spent at the window during each test was recorded. On Days 1 and 2, the *S*s simply looked through the plastic box at the stimulus monkey. On Days 3, 4, and 5, however, a small snake was placed in the box and, in order to see the other monkey, the *S*s had to look past the snake. The mean viewing times per test session were 2.78, 2.60, 0.65, 0.79 and 1.08 minutes for Days 1 through 5, respectively. On Days 3, 4, and 5, no viewing-time score for any *S* was as high as its lowest score on Days 1 and 2.

C. DISCUSSION

In connection with the Group I experiments, exposure to the several stimulus objects that were chosen for their possible fear-provoking properties failed to suppress, or greatly decrease, viewing behavior. The view of the anesthetized monkey may have provoked fear in the few monkeys tested, but it was clear that viewing the headless monkey failed to bring about a dramatic change in viewing behavior. Perhaps rhesus monkeys do not perceive a dismembered body of another monkey as something associated with a live animal of the same species. It may have been, however, that the criterion for fear established in this study was too stringent. Bodily withdrawal seems a reasonable index for fear, but in this test situation the monkeys may have been less frightened than otherwise because they always had the option of terminating exposure to the stimulus object by retreating an inch or two from the window. Moreover, the *S*s were never directly threatened by the stimulus objects, but were merely spectators remote from objects or actions. The spectator role of the *S*s may help explain why they apparently did not share the anxiety or fear that must have been experienced by the stimulus monkey when confined with three snakes. Again, it is not known whether the criterion for exhibiting fear was too strict. It may be that a rhesus monkey must participate actively in a situation before it can experience the fear or excitement that must be felt by monkeys actively engaged.

That the monkeys' viewing behavior is dependent on the "psychological" barrier between them and the fear-provoking object was suggested by the Group II experiments as well as by some Group I tests. Monkeys made no obvious attempt to avoid contact with the snake, provided they were separated from the snake by 12 inches or more and that some kind of barrier existed between the monkeys and the snakes. The *S*s, for example, looked at a distant box containing snakes as frequently as they looked at the box when empty. Also, they pulled a chain to illuminate the test box about as frequently when a snake was in the adjoining plastic box as they did when the plastic box was empty. If, however, the physical barrier was removed or the monkey was required to approach the snake closely to obtain something else (a view of another monkey), then monkeys actively avoided the snake. Most interesting was the situation in which the monkey and the snake were confined in the same totally dark box. In this situation, the monkey must know where the snake is before he can avoid it; hence, the avoidance response requires that the box be illuminated. The data from Conditions B and D indicate that the monkeys' behavior was directed toward keeping the box illuminated. This appears to be an adaptive response; yet two *S*s never did respond in Condition B at a rate approaching that recorded for them on the control tests. It is suggested that the strength of fear was greater in these monkeys than in the others and that this enhanced fear precluded an adaptive response to the situation. This inference, although reasonable, is without direct experimental support. Nonetheless, the sharp decrease in responsiveness when monkeys heard the alarm cries lends credence to the notion that strong fear was responsible for instances of decreased response rates. Hebb (4) has discussed such a notion in connection with the concept of level of arousal. He cited many examples—in animals as well as in man—in which fear can act as an energizer; however, with strong fear, the organism becomes immobilized. The data from some of the Group II experiments are consistent with this kind of interpretation.

D. Summary

In Group I experiments, monkeys were housed in an enclosed box, but they could look outside by approaching closely one of two windows. It was assumed that a view of a fear-provoking stimulus would suppress further viewing behavior; however, a view of an anesthetized monkey, a headless monkey, live snakes, or another monkey confined with the snakes failed to do this.

The *S*s in Group II experiments were housed in a completely dark box which could be temporarily illuminated by pulling a chain. On some test sessions, a snake was also in the box with the test animal. The *S*s pulled the chain more frequently to illuminate the box when the snake was present ($p < .05$). Some *S*s, however, showed a marked decrease in response rate when confined with the snake. All *S*s showed a decline in response rate when recorded alarm-cries of other monkeys were played to them through a loudspeaker. These data are interpreted in terms of fear acting both as an energizer and as a suppressor of behavior.

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VERIFICATION OF OBJECTIVE TEST PERSONALITY FACTOR PATTERNS IN MIDDLE CHILDHOOD*[1]

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A. INTRODUCTION

The twenty or more principal personality dimensions from objective, behavioral measures in adults may now be considered reasonably established. From the recent definitive studies and cross comparisons, often covering twelve or more researches, made by Damarin and Warburton (14) and by Hundleby, Pawlik, and Cattell (17), there can be little doubt regarding their number and their patterns though more complete interpretations and, especially, batteries of high validity for their practical measurement remain to be achieved.

At this point, therefore, the maximum theoretical interest turns to the continuation of such structural inquiries into childhood. From the abilities analogy one might perhaps expect roughly the same number of factors, though with loadings modified on particular tests and different correlations among primaries, expressing changing variance at the second-order level. On another flank—the extension of personality factor research into childhood in terms of the questionnaire media—we already have evidence of consistent structure over the 6-to-18-year-old range (7, 13).

So far, three researches with a truly comprehensive range of objective, behavioral tests, also carrying the important factor markers from the adult level, have been made on children—those of Cattell and Gruen (8) at the 12-year-old level, of Cattell and Coan (6) at the 8-to-9-year level, and of Cattell and Peterson (10) at the 4-to-5-year level. These gave definite evidence of continuity with the adult patterns and encouraged us to undertake the present study to consolidate factor conceptions at the 8-to-10-year level. Besides this theoretical objective, our study had the purpose of bringing the child O-A battery (4), increasingly used in child personality measurement, to a level of reliability and validity at which it could be usefully employed in exact nature-nurture research now being planned.

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B. Description of the Personality Tests

The participants in all the interlocking researches in this area have had the aim in test design of (*a*) comprehensiveness; (*b*) exact continuation of what prove to be factor markers, from study to study; (*c*) construction of new test devices in a hypothetico-deductive sequence in relation to emerging hypotheses about the factors, and (*d*) appropriate modification of markers to give maximum similarity of psychological meaning across age difference. Thurstone, indeed, put his finger on the right issue when he maintained (20) that success in this field would depend on psychological ingenuity in test construction. The Compendium (12) of over 500 objective personality tests tried out over the past 25 years of factor-analytic structural research, may give some idea of how comprehensive a sampling of total personality behavior has been achieved.

It was the impression of the present junior author in planning for this research that, in the childhood range, the Cattell and Coan study (8-to-9-year-olds) had strong emphasis on nonverbal material whereas the Cattell and Peterson study, despite the younger group (4-to-5-year-olds) had more verbal behavior. Also, it appeared that in some cases, marker tests had become modified across the three studies in ways which created a difficult choice for the present study, which was aimed to hit the middle of their age range. In the effort to devise tests meeting all requirements, we ran into the usual temptation to resort to individual apparatus testing, though both time requirements and later usefulness dictated group administration conditions.

Expecting 20 factors and inserting two markers for each, we already had 40 tests, and hypothesis testing, as well as exploration of suspected new dimensions, required 30 to 40 more. The reader unaware of this familiar dilemma in attempting to cover the personality sphere may need to recognize that brief tests of correspondingly low reliability are the deliberate strategy we have adopted, and that later intensive studies, like those of Hundleby and Pawlik in the adult field, are intended to raise the reliabilities and item validities of the tests found formally good.

The reliabilities of the tests used, their descriptive titles, and the M.I. (Master Index) or T (Objective Test) numbers under which their detailed experimental administration, rationale, and scoring may be looked up in the Compendium (12) or other articles are shown in Table 1.

It will be seen that variables 49-76 are derived from individual tests, that the remaining variables are derived from group tests (excepting 110, 111) and that the battery is therefore three-quarters group tests. Those individual

TABLE 1
MASTER LIST

Matrix No.	Master Index No.	Variable Title	Reliability
1	MI 206	Perceptual analysis. Gottschaldt. UI 19 Marker (total correct). Odds/evens.	.68
2	MI 168	High speed of social judgment. UI 21 Marker (no. completed). No rel.	—
3	MI 133	High criticalness of judgment. UI 24 Marker (severe choices). Odds/evens.	.66
4	MI 39	Tendency to sort by color rather than by form. UI 23 Marker (no. color choices). Odds/evens.	.89
5	T405	Preference for movement in pictures (total movement choices). Odds/evens.	.04
6	T431	Preference for natural scenes (total natural choices). Odds/evens.	.06
7	MI 429	Low preference for aggressive pictures. UI 17 Marker (aggressive choices). Odds/evens.	.73
8	MI 364	Predominance of internal over external control. UI 31 Marker (int. contr.). Odds/evens.	.22
9	MI 211	Annoyability. UI 24 Marker (3-point scale). Odds/evens.	.45
10	MI 359	Many extreme annoyance responses. UI 24 Marker (extremes on very annoyed). No rel.	—
11	MI 212	High aspiration and many distant goals attainable. UI 16 Marker (yes responses). Odds/evens.	.42
12	MI 219	Honesty in admitting common frailties. UI 20 Marker (responses dir. admission). Odds/evens.	.61
13	MI 27	Willingness to play practical jokes. UI 17 Marker (yes responses). Odds/evens.	.44
14	MI 21	Absence of questionable reading preferences. UI 17 Marker (orthodox choices). Odds/evens.	.67
15	MI 309	Rapid and accurate line judgment. UI 16 Marker (no. correct). 1st/2nd part.	.45
16	MI 382	Rapid evaluative judgments. UI 16 Marker (no. completed). 1st/2nd part.	.52
17	MI 379	Rapid pencil maze performance. UI 16 Marker. $A + C$ vs. $B + D$.	.79
18	MI 380	Errors in pencil maze performance. UI 22 Marker. $A + C$ vs. $B + D$.	.60
19	MI 120	Ratio errors to distance travelled in pencil maze. UI 22 Marker. $A + C$ vs. $B + D$.	.71
20	MI 101	Excess aspiration over performance. Mazes B and C only B vs. C.	.48
21	MI 203	Self-confidence in computational skill. UI 31 Marker (will try checked). Odds/evens.	.57
22	MI 199	High computational skill. UI 32 Marker (no. correct). Odds/evens.	.53
23	MI 273	High proportion of fluency on self. UI 26 Marker (total on 1, 3, 5 vs. 2, 4, 6). No rel.	—
24	T434a	Speed on letter cancellation (no. correctly circled). 1st vs. 2nd page.	.69
25	T434b	Ratio errors/accuracy in letter cancellation (errors/no. ac. %). 1st vs. 2nd page.	.33

TABLE 1 (*continued*)

Matrix No.	Master Index No.	Variable Title	Reliability
26	MI 17	High tendency to agree. UI 20 Marker ("yes" to both items). Odds/evens.	.19
27	MI 67	Total number of "agree" responses recalled correctly. UI 28 Marker. No rel.	—
28	MI 101	Little excess of aspiration over performance. UI 27 Marker. No rel.	—
29	MI 145	Responsiveness aspiration level to performance. UI 27 Marker. No rel.	—
30	T433a	Performance in coding test (score 3 scores). 2nd vs. 3rd page.	.70
31	MI 193	Ego weakness: shift to successfuls. UI 27 Marker (prestige shift). Odds/evens.	.09
32	MI 247	Small size of copied drawing. UI 25 Marker (size of circle, square). 1st/2nd page.	.66
33	MI 30	Little criticism of others relative to self. UI 26 Marker. No rel.	—
34	T433b	Excess of pleasant to unpleasant comment on others. No rel.	—
35	T433c	Excess of pleasant to unpleasant comment on self. No rel.	—
36	MI 51	High index of carefulness. UI 19 Marker. Odds/evens.	.73
37	T433d	No. of lines used in shading. Odds/evens.	.80
38	MI 134	Much self-criticism relative to criticism of others. UI 18 Marker. D/B vs. C/A.	.62
39	MI 385	Rapid and accurate shape comparison. UI 18 Marker. 1st/2nd half.	.61
40	MI 266	CMS (child). Ratio initial/final performance. UI 18 Marker. No rel.	—
41	MI 143	CMS (child). UI 18 Marker (total correct). Odds/evens.	.76
42	MI 98	CMS (child). UI 29 Marker (proportion correct). Odds/evens.	.55
43	MI 15	CMS (child). UI 29 Marker (total errors). Odds/evens.	.55
44	MI 348	Readiness to reject loose generalizations. UI 20 Marker. Odds/evens.	.21
45	MI 282	Threat and fluency of perception: unstructured drawings. UI 21 Marker. Odds/evens.	.80
46	MI 105	Unstructured drawings: perception of threatening objects. Odds/evens.	.30
47	MI 2	Motor perceptual rigidity: backward writing. UI 23 Marker. Odds/evens.	.27
48	MI 280	High accuracy in time estimate. UI 31 Marker. Odds/evens.	.29
49	MI 356	Rapid color naming. UI 23 Marker (errors). No rel.	—
50	MI 6	Rapid color naming. UI 25 Marker (total completed). No rel.	—
51	MI 2	Total correct in reverse color naming. UI 23 Marker. No rel.	—
52	MI 426	Distractibility in picture inspection task. UI 19 Marker. Odds/evens.	.85

TABLE 1 (*continued*)

Matrix No.	Master Index No.	Variable Title	Reliability
53	MI 428	Attention to disturbing pictures. UI 19 Marker. Odds/evens.	.77
54	MI 430	Preference for disturbing pictures. UI 19 Marker. Odds/evens.	.53
55	MI 7	Slowness of Gestalt completion. UI 25 Marker. Odds/evens.	.71
56	MI 146	Accuracy in identifying incomplete drawings. UI 25 Marker. Odds/evens.	.35
57	T404	Acceptance of authority suggestion.	.43
58	MI 339	Slow in mirror drawing. UI 28 Marker. 1st/2nd sheet.	.35
59	MI 357	Meandering in mirror drawing. UI 28 Marker. 1st/2nd sheet.	.37
60	MI 175	Fast irregularly warned RT. UI 22 Marker. Odds/evens.	.76
61	MI 176	Fast regularly warned RT. UI 22 Marker. Odds/evens.	.70
62	MI 40	Many reactions to false RT signals. UI 22 Marker. Pts. A vs. B.	.27
63	MI 263	Low variance in RT. UI 22 Marker (est. by range). Pts. A vs. B.	.29
64	MI 71	Many errors in complex RT. UI 22 Marker. Odds/evens.	.37
65	MI 72	High ratio of complex to simple RT. UI 29 Marker. No rel.	—
66	MI 235	Fast Complex RT. UI 22 Marker. No rel.	—
67	T406	Effort in balloon expansion. 1st balloon/2nd balloon.	.80
68	MI 421	Cautious anticipation in tower construction.	.12
69	MI 422	Height of single tower construction. 1st trial/2nd trial.	.21
70	T402a	Dermographia (a) latency. Left arm/right arm (sec.).	.59
71	T402b	Dermographia (b) persistence. Left arm/right arm (min.).	.95
72	T403	Finger temp. Reading 1/Reading 2. (Deg. F discrepancy over room temp.).	—
73	MI 122	Body sway. UI 27 Marker. Reading 1 range/Reading 2 range (in.).	.68
74	MI 42	Suggestibility. UI 27 Marker. No rel.	—
75	T422	Breath-holding. Two 30-sec. periods.	.63
76	MI 270	Tempo of arm-shoulder movement. UI 30 Marker. 1 period/2 period (15 sec.).	.97
77	T400(a)	Elation depression: mood swings (total score). Odds/evens.	.59
78	T400(b)	Elation depression: extremes (total extremes). No rel.	—
79	T401	Confidence in public appearance. Odds/evens.	.15
80	T407	Paired associations (aimed at UI 21, UI 32). Odds/evens.	.18
81	T408(a)	Identification with main character in theme. Odds/evens.	.28
82	T408(b)	Choice of approved vs. nonapproved character. Odds/evens.	.35

TABLE 1 (*continued*)

Matrix no.	Master index no.	Variable title	Reliability
83	T408(c)	Knowledge of themes (total checked). Odds/evens.	.82
84	T409	Acceptance of unlikely statements. Odds/evens.	.40
85	T410	Strategy span. 2 + 4 vs. 3 + 5.	.57
86	T411	Dour or cheerful projection. Odds/evens.	.41
87	T412(a)	Compliance in the face of discomfort. No rel.	—
88	T412(b)	Liking of unpleasant activities (1st 14 items). Odds/evens.	.35
89	T412(c)	Doing unpleasant activities (1st 14 items). Odds/evens.	.50
90	T413	Personal care and neatness. No rel.	—
91	T415	Judgment of animate vs. inanimate objects.	.04
92	T416	Confidence in factual rather than emotional items. No rel.	—
93	T417(a)	Preference for successful tasks (no. of tasks *S* likes to do). No rel.	—
94	T417(b)	Ratings for task preference. Odds/evens.	.81
95	T418(a)	Fewness of friends. Totals pp. 1 and 2. No rel.	—
96	T418(b)	Strength of outgoing respect. No rel.	—
97	T420	Rapidity of decision. ACE vs. BDF.	.51
98	T421(a)	Total of approaches to parental authority. Odds/evens.	.01
99	T421(b)	Preponderance of own sex parental approach. No rel.	—
100	T423	Degree of honesty: success in guessing. Odds/evens.	.82
101	T424	Awareness of observation. lhs/rhs.	.72
102	T426(a)	Aggressive picture interpretation. Odds/evens.	.17
103	T426(b)	Aggressive picture recall. No rel.	—
104	T428	Mechanical vs. natural intervention. Odds/evens.	.07
105	T429(a)	Self concept tested by visual symbols (volatility).	—
106	T429(b)	Self concept tested by visual symbols (morality).	—
107	T430	Spatial integration. Pt. 1/Pt. 2.	.60
108	T432(a)	Rapid shape formation decisions. (1) No. of shapes correctly identified. Pt. 1/Pt. 2.	.17
109	T432(b)	Rapid shape formation decisions. (2) Stage of shape decision. Pt. 1/Pt. 2.	.45
110		Spare variable X (Age).	—
111		Random variable.	—

tests remaining in the design either supplied crucial markers (e.g., reaction time as a U.I. 22 marker) or provided promising new tests for a factor [e.g., dermographia as a possible U.I. 32 test (McLeod, 1954)]. Those tests adopted from previous O-A batteries are given M.I. numbers, new tests are given T numbers, although in some cases (e.g., variable 15) a new test was designed but given an M.I. number as it was not considered to be an alteration of test meaning (at the time, although judging by the results it was). Essentially, therefore, the test battery, although modified to the 8-to-10-year level and predominantly in group form—and with certain other characteristics, such as simplicity of instructions and administration (and scoring layout)—contained about half new and about half old test invention.

C. Sample

One hundred and ninety-seven complete sets of data were obtained from grade-school children (half male, half female), mean age 8.8 years, within a 60-mile radius of Champaign-Urbana, Illinois. The group test portion of the battery took approximately 7½ hours to administer, the individual tests about one-half hour per child. The largest group tested at any one time consisted of 37 subjects; the smallest group, of 14 subjects.

D. Analysis of Data

1. *Correlation Matrix*

A correlation matrix was obtained from raw scores using the Illiac K-8 program giving Pearson product-moment correlations and standard deviations for each variable. Reliabilities and distributions for each variable were also computed. The correlation matrix was subjected to centroid factor analysis with estimated communalities and, on the basis of Tucker's (1938) criterion, a 22-factor centroid was accepted for rotation.

Rotation was carried out both by blind search for maximum simple structure and by what is called the Procrustes program, designed by Hurley and Cattell for the Illiac computer. In this a matrix is written out, of the same number of factors as the centroid and of approximately the same communality per variable, in which existing hypotheses about the factors are set out as loading patterns. The computer is then asked to rotate the obtained centroid to see how close it can get to the hypothesized factor pattern matrix. This constitutes the most objective approach yet devised in using factor analysis as an hypothesis-testing method in a hypothetico-deductive sequence, providing tests are made of the goodness of fit, along the lines suggested by Cattell and Baggaley (5), Kaiser (18) and Tucker (21). The patterns to represent the hypothesis here were the loadings of the marker variables on the expected personality factors averaged across all previous relevant studies. The blind search for simple structure was then carried on from the Procrustes solution. The latter was at a position that many published researches have accepted as simple structure, but we continued to rotate 16 times (all factors changed on each) until the hyperplane count had risen to 69 per cent. Using Bargmann's (1) criterion, we found at this point that all but Factor 6 were significant beyond the .01 level, the number of hyperplane variables ranging from 68 (Factor 6) to 90 (Factor 9).

Identification of factors at this unique simple structure position was made in terms of markers using:

1. Marker count—number of markers out of total possible loading .15 or above.

2. Sign count—ratio sign loadings consistent with the required pole of the particular U.I. factor.

3. Average absolute difference in size of marker loadings between present and previous delineation of the factor.

4. Inner product ["unadjusted correlation coefficient" of Burt (2)] vectors. The "criterion" between the matched factor pattern in each match was the weighted average across studies used as a hypothesis statement in the Procrustes rotation. This was used for factors U.I. 16 through 28 and 30 through 32.

On this basis it proved relatively easy to identify the following factors:

Present study factor number:	1	3	4	6	7	8	9	10	12	13	16	17	21	22
Universal index U.I. number:	16	18	17	21	22	23	24	19	−30	28	27	32	29	25

2. *Replicated Factor Patterns*

A description of the replicated factors will now be given, treating the factors in descending order of variance contribution to the present study. We have followed the practice of presenting salient loadings down to the .20 level plus loadings on markers whether or not these have proved to be salients in the given case.

TABLE 2

FACTOR 1: U.I. 16 ASSERTIVENESS

Matrix no.	Master index	Variable title	Loading
19	MI 120	High ratio errors to distance travelled in pencil maze	.79
18	MI 380	High errors in pencil maze performance	.68
17*	MI 379	Rapid pencil maze performance	.52
20	MI 101	Excess performance over aspiration	—.31
36	MI 51	High index of carefulness	.28
51	MI 2	Low total correct in reverse color naming	—.25
49	MI 356	Rapid color naming (errors)	.21
24*	T434a	High speed on letter cancellation	.20
8	MI 364	Low predominance of internal over external control	—.20
107	T430	Low spatial integration	—.20
38*	MI 134	Much self-criticism relative to criticism of others	.16
11*	MI 212	High aspiration and many distant goals attainable	.05
15*	MI 309	Less rapid and accurate line judgment	—.02
16*	MI 382	Less rapid evaluative judgments	—.01

* Marker variables.

Thus for the identification of Factor 1 as U.I. 16, the hyperplane of which is significant beyond the .001 level by Bargmann count, several markers had negligible loadings, but the general picture emerging, plus criterion indications, did not disagree with the established interpretation of assertiveness (sometimes called *harric assertiveness*) as exemplified by a person who is out to make a very high achievement and who has a quality of resource and of readiness to cope with difficulties. Unlike the 4-to-5-year level, which shows high aspiration level, and unlike the pattern at the 6-to-7-year level, which stresses accuracy as well as speed in maze performance, the present pattern seems to show speed at the expense of errors and an absence of any *consciously* high aspiration. It therefore points to a more dispositional interpretation like "eagerness."

TABLE 3
FACTOR 3: U.I. 18 HYPOMANIC SMARTNESS

Matrix no.	Master index	Variable title	Loading
15	MI 309	Slow and inaccurate line judgment	—.48
35	T433c	Excess of unpleasant to pleasant comment on self	—.47
39*	MI 385	Rapid and accurate shape comparison	.44
13	MI 27	More willingness to play practical jokes	.44
107	T430	High spatial integration	.34
12	MI 219	More honesty in admitting common frailties	.31
106	T429b	Self concept tested by visual symbols: less morality	—.27
23	MI 273	Low proportion of fluency on self	—.24
16	MI 382	Rapid evaluative judgments	.23
41*	MI 143	CMS (child). High total correct	.23
85	T410	High strategy span	.23
33*	MI 30	More criticism of others relative to self	—.23
47	MI 2	High motor perceptual rigidity: backward writing	.21
38*	MI 134	Much self-criticism relative to criticism of others	.15
68*	MI 421	Less cautious anticipation in tower construction	—.09
40*	MI 266	CMS (child). High ratio initial/final performance	.08
4*	MI 39	High tendency to sort by color rather than by form	.07
43*	MI 15	CMS (child). Low total errors.	—.05
69*	MI 422	High height of single tower construction	.04

* Marker variables.

As theoretical descriptions have been provided for the consensus of child O-A studies before the present one (9), main agreements and divergencies *only* will be indicated for each factor. This factor—U.I. 18—was not found clearly by Cattell and Peterson (10) in 4-to-5-year-olds, but was sufficiently clear in Cattell and Coan (6), representing a general picture of hypomanic insecurity coupled with shrewdness and "cutting corners" in "looking after oneself" in a world of competition. Again it loads self-criticism, realism with low morality score, and rash expediency and haste in solving problems.

TABLE 4
FACTOR 4: U.I. 17 TIMIDITY

Matrix no.	Master index	Variable title	Loading
53	MI 428	Less attention to disturbing pictures	—.64
54	MI 430	Less preference for disturbing pictures	—.54
52	MI 426	High distractibility in picture inspection task	.46
3	MI 133	Less criticalness of judgment	—.34
14*	MI 21	Few questionable reading preferences	.27
78	T400b	High elation depression: extremes	.26
17	MI 379	Less rapid pencil maze performance	—.25
92	T416	Less confidence in factual rather than emotional items	—.24
48	MI 280	Low accuracy in time estimate	—.23
40	MI 266	CMS (child). High ratio initial/final performance	.22
109	T432b	Low stage of shape decision	—.22
7*	MI 429	Less preference for aggressive pictures	—.13
13*	MI 27	High willingness to play practical jokes	.07
55*	MI 7	High slowness of Gestalt completion	.03
46*	MI 105	Unstructured drawings: high perception of threatening objects	.01

* Marker variables.

The general picture which emerges in the case of U.I. 17 is in good agreement with the pattern of timidity or general inhibition previously found in both adults and children.

TABLE 5
FACTOR 6: U.I. 21 EXUBERANCE

Matrix no.	Master index	Variable title	Loading
52	MI 426	Less distractibility in picture inspection task	—.45
53	MI 428	High attention to disturbing pictures	.39
61	MI 176	Fast regularly warned RT	.34
38	MI 134	Much self-criticism relative to criticism of others	.33
90	T413	High personal care and neatness	.28
63	MI 263	Low variance in RT	.27
65	MI 72	High ratio of complex to simple RT	.27
12	MI 219	High honesty in admitting common frailties	.26
45*	MI 282	High threat and fluency of perception: unstructured drawings	.24
55*	MI 7	Slow speed of Gestalt completion	—.24
64	MI 71	Fewer errors in complex RT	—.24
46	MI 105	Unstructured drawings: high perception of threatening drawings	.23
43	MI 15	CMS (child). Fewer total errors	—.23
56	MI 146	High accuracy in identifying incomplete drawings	.21
42	MI 98	CMS (child). Low proportion correct	—.21
101	T424	Low awareness of observation	—.21
81	T408a	Less identification with main character in theme	—.20
2	MI 168	High speed of social judgment	.15

* Marker variables.

Rather than exuberance *per se* (as in high fluency and high imaginative perception of hidden objects) the present factor carries an impression of a subject who is able to concentrate on the task in hand. In agreement with high perception of threatening objects, in previous studies, the child pays attention to disturbing pictures and, in a separate test, responds to unstructured drawings in terms of threatening objects.

TABLE 6
FACTOR 7: U.I. 22 CORTICALERTIA

Matrix no.	Master index	Variable title	Loading
61*	MI 176	Fast regularly warned RT	.73
60*	MI 175	Fast irregularly warned RT	.64
65*	MI 72	High ratio of complex to simple RT	.49
102*	T426a	High aggressive picture interpretation	.40
63*	MI 263	Low variance in RT	.38
11	MI 212	Low aspiration and few distant goals considered attainable	—.31
5	T405	Less preference for movement in pictures	—.22
66*	MI 235	Fast complex RT	.19
62*	MI 40	Many reactions to false RT signals	—.10
19*	MI 120	High ratio errors to distance travellel in pencil maze	.08
64*	MI 71	Many errors in complex RT	—.06
18*	MI 380	High errors in pencil maze performance	.00

* Marker variables.

In Factor 7 five markers are salients and the general meaning is retained of "nervous alert reactivity" or "arousal," to use the currently fashionable concept. However, no new tests appear on this factor. It continues to be mainly marked by reaction-time measures and, fairly obviously, a good deal of thought will need to be given to transform this factor into group test forms.

Factor 8: As in both previous child studies, this "neurotic" factor (11, 15) is clearly separable from U.I. 24 Anxiety. It is interesting to note that in the present instance: (*a*) age is negatively related to U.I. 23, and (*b*) three new variables load appreciably on the factor (T412a and b and c, T423), but these do not alter the meaning of the factor which has an interim identification as neurasthenia or inadequate personality, and which interpretation would seem to be confirmed by the new variables found to load here.

Although relatively few variables appear on this factor in the present study, three markers are present—two of them high in loading. Of the new tests loading here, T412c and T433d add to the meaning of the factor. It is of interest to note that number of lines used in shading (loaded negatively on

TABLE 7

FACTOR 8: U.I. 23 ERGIC REGRESSION

Matrix no.	Master index	Variable title	Loading
89	T412c	Less readiness for doing unpleasant activities	—.52
110		Spare variable *X* (Age)	—.44
47*	MI 2	Low motor perceptual rigidity: backward writing	—.39
32	MI 247	High small size of copied drawing	.29
100	T423	Low degree of honesty: success in guessing	—.27
1	MI 206	Good perceptual analysis	.26
13	MI 27	High willingness to play practical jokes	.26
88	T412b	Less liking of unpleasant activities	—.26
87	T412a	Low compliance in the face of discomfort	—.24
90	T413	High personal care and neatness	.23
84	T409	Less acceptance of unlikely statements	—.22
38	MI 134	Much self-criticism relative to criticism of others	.21
22	MI 199	High computational skill	.20
12*	MI 219	High honesty in admitting common frailties	.15
4*	MI 39	High tendency to sort by color rather than by form	.08
74*	MI 42	Low suggestibility	—.08
19*	MI 120	Low ratio errors to distance travelled in pencil maze	—.05

* Marker variables.

TABLE 8

FACTOR 9: U.I. 24 ANXIETY

Matrix no.	Master index	Variable title	Loading
9*	MI 211	High annoyability	.82
10*	MI 359	Many extreme annoyance responses	.78
110		Spare variable *X* (Age)	—.44
89	T412c	Less readiness for doing unpleasant activities	—.31
88	T412b	Less liking of unpleasant activities	—.22
37	T433d	Fewer lines used in shading	—.20
3*	MI 133	High criticalness of judgment	.12
76*	MI 270	Slow tempo of arm-shoulder movement	—.02

* Marker variables.

U.I. 24) loads on only one other factor, identified as U.I. 32 in the present study, but loads positively thereon. Hence this test might be a useful item in a battery differentiating between the important factors of anxiety and introversion-extraversion.

This factor does not rival the excellent match for U.I. 19 in previous child studies, but the meaning is clear. Although variable 55, the highest loading, was not a U.I. 19 marker, its meaning agrees with variable 36 in Coan's study, good analysis performance on Gottschaldt figures, a U.I. 19 marker in the latter case.

When this factor is reversed, one sees a picture of an egocentric type of person who performs well in several tasks, has few friends, is personally

TABLE 9
FACTOR 10: U.I. 19 PROMETHEAN WILL

Matrix no.	Master index	Variable title	Loading
55	MI 7	Faster speed of Gestalt completion	—.63
56	MI 146	High accuracy in identifying incomplete drawings	.53
24	T434a	High speed of letter cancellation	.30
35	T433c	High excess of pleasant to unpleasant comment on self	.30
1*	MI 206	High perceptual analysis (Gottschaldt test)	.29
15	MI 309	Less rapid and accurate line judgment	—.29
85	T410	Low strategy span	—.26
77	T400a	High elation depression: mood swings	.23
91	T415	High judgment of animate vs. inanimate objects	.21
14	MI 21	High absence of questionable reading preferences	.20
47*	MI 2	Low motor perceptual rigidity: backward writing	—.18
36*	MI 51	Low index of carefulness	—.12
53*	MI 428	High attention to disturbing pictures	.06
52*	MI 426	Low distractibility in picture inspection task	—.02
54*	MI 430	Low preference for disturbing pictures	—.02

* Marker variables.

TABLE 10
FACTOR 12 (—): U.I. 30 INDEPENDENCE (STOLIDITY)

Matrix no.	Master index	Variable title	Loading
93	T417a	Low preference for successful tasks	—.63
94	T417b	Low ratings for task preference	—.61
95	T418a	More friends recalled on fluency test	—.51
41*	MI 143	CMS (child). Low total correct.	—.49
30	T433a	Low performance in coding test	—.42
24	T434a	Slow speed on letter cancellation	—.40
90	T413	Less personal care and neatness	—.38
45	MI 282	Low threat and fluency of perception: unstructured drawings	—.35
27	MI 67	Low total of "agree" responses recalled correctly	—.31
3	MI 133	High criticalness of judgment	.30
97	T420	Slower speed of decision	—.27
108	T432a	Slower speed of shape formation decisions	—.27
74	MI 42	High suggestibility	.26
107	T430	Low spatial integration	—.25
17	MI 379	Slower speed of pencil maze performance	—.24
106	T429b	Low self concept tested by visual symbols	—.20
47*	MI 2	High motor perceptual rigidity: backward writing	.07
42*	MI 98	CMS (child). High proportion correct	.04
76*	MI 270	Tempo of arm-shoulder movement	.03

* Marker variables.

fastidious, and is insuggestible. Taken overall, the loadings on Factor 12 are regarded as a good match for U.I. 30 despite the negligible loading of tempo of arm-shoulder movement (modified slightly from previous forms with a stopping point at each end of a straight travel movement rather than a continuous circling rhythm) and, if accepted, will represent the first occasion in which this factor has appeared with some clarity in children.

This factor has all included markers present, in correct sign and strong loading. However, it lacks broadening by new tests and represents a verification rather than an addition. Both at the 8-to-10-year level and at the 6-to-9-year level, it has appeared with greater clarity than at the 4-to-5-year level. This does not conflict with the earlier hypothesis (3) of early fixation on a strict parent, with subsequent ambivalence and conflict over authority figures.

TABLE 11
FACTOR 13: U.I. 28 RIGID SUPEREGO

Matrix no.	Master index	Variable title	Loading
58*	MI 339	Slow in mirror drawing	.68
59*	MI 357	High meandering in mirror drawing	.67
17	MI 379	Slower speed of pencil maze performance	—.35
66	MI 235	Fast complex RT	.34
60	MI 175	Fast irregularly warned RT	.28
15	MI 309	Rapid and accurate line judgment	.20
110		Spare variable *X* (Age)	—.20
27*	MI 67	High total number of "agree" responses recalled correctly	.13
19*	MI 120	Low ratio errors to distance travelled in pencil maze	—.09

* Marker variables.

TABLE 12
FACTOR 16: U.I. 27 APATHETIC TEMPERAMENT

Matrix no.	Master index	Variable title	Loading
76	MI 270	Slow tempo of arm-shoulder movement	—.54
28*	MI 101	More excess of aspiration over performance	—.41
67	T406	Less effort in balloon expansion	—.39
26	MI 17	High tendency to agree	.33
83	T408c	Less knowledge of themes	—.31
21	MI 203	Low self-confidence in computational skill	—.29
68	MI 421	Less cautious anticipation in tower construction	—.27
92	T416	High confidence in factual rather than emotional items	.25
40	MI 266	CMS (child). Low ratio initial/final performance	—.23
72	T403	Higher finger temperature	.22
70	T402a	Dermographia (a) high latency	.21
98	T421a	Fewer total approaches to parental authority	—.21
79	T401	High confidence in public appearance	.20
31*	MI 193	Ego weakness: high shift to successfuls	.16
29*	MI 145	High responsiveness aspiration level to performance	.11
74*	MI 42	Low suggestibility	—.07
73*	MI 122	Low body sway	—.06

* Marker variables.

It is interesting to note that several new tests load on this factor, including (lack of) effort given to balloon expansion, (lack of) self-confidence in computational skill—a new test design, (absence of) confidence in emotional items, (high) finger temperature, (long) latency of dermagrophia. The picture is thus one of a child who is relaxed, but whether he is relaxed because he is apathetic, or the reverse, is not possible to state at this juncture.

TABLE 13
FACTOR 17: U.I. 21 EXVIA-INVIA

Matrix no.	Master index	Variable title	Loading
68	MI 421	Less cautious anticipation in tower construction	—.57
69*	MI 422	Low height of single tower construction	—.51
40	MI 266	CMS (child). High ratio initial/final performance	.42
37	T433d	Number of lines used in shading	.28
38	MI 134	Little self-criticism relative to criticism of others	—.27
7	MI 429	High preference for aggressive pictures	.27
6	T431	Low preference for natural scenes	—.26
48	MI 280	Less accuracy in time estimate	—.25
98	T421a	Fewer approaches to parental authority	—.24
8	MI 364	Low predominance of internal over external control	—.23
71	T402b	Dermographia (b) low persistence	—.20
12*	MI 219	Little honesty in admitting common frailties	—.04

* Marker variables.

This primary-objective test factor is taken to correspond to a second-order Q-data factor of extraversion-introversion. Because the latter has now become so popular a newspaper term as to be scientifically valueless, the label Exvia-Invia has been introduced when referring to the exact factor. A number of variables deriving from tower construction (using blocks) loaded highly on U.I. 32 in Cattell and Coan (6) and have appeared again in this childhood factor tentatively identified as U.I. 32. The exviant individual is evidently impulsive, rushes into things, does not plan ahead, manifests low accuracy in time estimation, prefers artificial (man-made) objects to natural surroundings, and shows a predominance of external over internal control. Further he deteriorates (or fails to improve) as he goes along in CMS (the Cursive Miniature Situation test, not unlike the simpler tracking-vigilance test), and makes errors in rapid color naming. All these variables fit the general theory of exvia-invia (11) well enough for us to be fairly sure of the identification of U.I. 32 in the 8-to-10-year range.

Factor 21: Alternatively interpreted in some studies as a deliberate, *willed* responsiveness, this factor—"activity-vs.-fatigue"—appeared at the 4-to-5-year level but not at the 6-to-8-year level. If the present tentative identification is cor-

TABLE 14
FACTOR 21: U.I. 29 IMMEDIATE RESPONSIVENESS

Matrix no.	Master index	Variable title	Loading
30	T433a	High performance in coding test	.51
24	T434a	High speed on letter cancellation	.41
36	MI 51	Low index on carefulness	—.30
78	T400b	Elation depression: fewer extremes	—.30
41	MI 143	CMS (child). High total correct	.29
19	MI 120	Low ratio errors to distance travelled in pencil maze	—.27
44	MI 348	Low readiness to reject loose generalizations	—.26
77	T400a	Elation depression: few mood swings	—.24
28	MI 101	Much excess of aspiration over performance	.23
11	MI 212	Low aspiration and few distant goals considered attainable	—.22
46	MI 105	Unstructured drawings: less perception of threatening objects	—.22
74	MI 42	Low suggestibility	—.22
16	MI 382	High rapid evaluative judgments	.20
99	T421b	High preponderance of own sex parental approach	.20

* Marker variables.

rect, the pattern is real enough in children, being characterized by high loadings on several speed tests combined with carelessness (variable 36). Nevertheless, the identification has to be tentative for the reason that on sign count this factor (Factor 21) was first thought to be U.I. 25.

Factor 22: Conceptually this factor is to be distinguished from *wary* realism

TABLE 15
FACTOR 22: U.I. 25 REALISM-VS.-IMAGINATIVE TENSION

Matrix no.	Master index	Variable title	Loading
2	MI 168	Slow speed of social judgment	—.53
16	MI 382	Slower speed of evaluative judgments	—.46
72	T403	High finger temp.	.35
86	T411	High dour or cheerful projection	.35
90	T413	Less personal care and neatness	—.31
8	MI 364	High predominance of internal over external control	.30
45	MI 282	Lower threat and fluency of perception: unstructured drawings	—.30
85	T410	Low strategy span	—.24
6	T431	High preference for natural scenes	.21
48	MI 280	High accuracy in time estimate	.21
22*	MI 199	Low computational skill	—.20
74	MI 42	Low suggestibility	—.20
32*	MI 247	Large size of copied drawing	.14
65*	MI 72	High ratio of complex to simple RT	.08
55*	MI 7	Faster speed of Gestalt completion	—.03
63*	MI 263	High variance in RT	.00

* Marker variables.

U.I. 31, which is not identified in the present study, and, in view of some similarity of loading pattern, from U.I. 29 above. The positive pole on this factor shows realistic, disciplined mental performance whereas the negative pole shows quick imaginative action. The factor has been called Accurate Realism vs. Psychotic Tendency since the negative aspect of this pattern has been claimed by Eysenck (16) to distinguish psychotics from normals but not neurotics from normals. However, more recent research (11) fails to find that the factor significantly differentiates normals from a stratified sample of psychotics and raises the question whether Eysenck's psychotic group may not have been predominantly depressives, or some one syndrome group. In the 25 (—)—i.e., Imaginative Tension—direction, this factor in children shows external control, high speed of social judgment, personal neatness, cheerful projection (*cf.,* surgency which joins cyclothymia in the second-order Q-data Exvia pattern), and, expansiveness in copying drawings.

The remaining factors cannot be identified with reasonable certainty, 11 and 14 being "candidates" for the missing U.I. 20, but candidates with insufficient qualifications. However, in summary, considering the changes inevitable in adapting tests across age, and the pressure of the long testing program on subjects working in some cases on the edge of their reading ability (particularly in variables such as 2, 3, 9, 10, 11, 13, 14, 26, 27, 31, 81, 82, 83, 84, 92, 93, 94, 98, 99), some gratification seems justified in that, of the factors U.I. 16 through U.I. 30, plus U.I. 32, all except U.I. 20 and 26 have been identified with reasonable certainty. In all, some 14 factors have appeared at the given age level in a form parallel and recognizable as factors which have made their initial appearance in a series of replicative adult studies and in two child studies, plus the early study by Cattell and Gruen (8). The remaining factors which cannot be identified in this study—U.I. 31, 33, 34, 35, 36—are factors of small variance and poor definition in previous work (3), as their high U.I. numbers (far down the variance series) show.

E. SUMMARY

In a replicative research designed to check objective personality factors in the 8-to-10-year range, both new test designs and marker tests were included in a battery (111 variables) administered to 197 subjects, mean age 8.8 years. By centroid factor-analytic procedures, 22 factors were initially extracted and rotated to maximum (statistically significant by test) simple structure (oblique) after 16 overall rotations. Fourteen factors were readily matched with those appearing in previous definitive child and adult studies,

and it turned out that these were the majority of the factors of previously highest variance and clearest psychological interpretation (U.I. 16 through 30, plus U.I. 32). This is taken as verification of the existence of replicable personality factors despite changes in test design and differing age of subjects. New tests in several cases contributed to clarification of hypotheses about these factors.

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VARYING STIMULATION AND IMPRINTING IN DOGS* [1]

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A. INTRODUCTION

In recent years considerable attention has been given to the problem of how the young organism comes to know its own species. Investigative techniques have changed from observations of the mother-infant relationship to studies of the specific variables which are involved in the development of the relationship. Most of the work on this problem, however, has been limited to studies of imprinting in precocial birds. Imprinting in guinea pigs, sheep, deer, and buffalo has been reported, but most of these reports are of an observational nature (5, 14).

Moltz (9) has postulated anxiety reduction as the reinforcement for the behavior observed in imprinting studies, because the responses have been shown to strengthen when the object is accompanied by aversive stimulation (shock). The low anxiety created by the unfamiliar results in anxiety reactions which become conditioned to an attention-evoking object. Specifically, Moltz says,

> When anxiety is aroused, any response instrumental in bringing the animal in contact with the familiar object will be closely followed in time by anxiety reduction due to the previously acquired capacity of the object to elicit responses incompatible with anxiety. Vigorous pursuit of the object should then occur until either the stimulus situation ceases to arouse anxiety or, the reward value of the object is extinguished (9, p. 304).

It is not necessary to posit anxiety reduction, however, if varying stimulation is considered to be the reinforcement for the imprinting responses. In the studies on imprinting, the imprinted object characteristically moved past the young birds and they followed it. That is, varying exteroceptive and

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[2] This paper is based on a Ph.D. dissertation at Michigan State University. The author is indebted to Stanley Ratner for his guidance of the dissertation.

proprioceptive stimulation can be considered to have been present. Specifically, the moving object supplies visual stimulation and the movements of the young bird resulted in kinesthetic stimulation. In those studies in which shock and flickering lights were shown to enhance imprinting, varying stimulation could also be postulated.

In this paper, exteroceptive stimulation will be considered to be physical energy which is converted into receptor energy by the senses of vision, hearing, taste, smell, touch, pain, and temperature. Proprioceptive stimulation will refer to that mediated by the vestibular and kinesthetic senses. The distinction between various kinds of stimulation is still a serious theoretical problem, but the theoretical distinctions are not important for the purposes of the present investigation. Conventional names are being used.

Hebb (4) has pointed out that stimulus deprivation studies with mammals and "brainwashing" experiments on humans suggest that varying exteroceptive stimulation is a universal reinforcing agent. The studies on imprinting of precocial birds suggest that varying stimulation may be the reinforcement for the responses of the young birds. In addition, observations of the mother-infant relationship among mammals show that varying stimulation is characteristically supplied to the young animals by the mother. The mother rat, dog, or cat, upon returning to the nest, often licks the bodies of the young before feeding them. This licking appears to be very vigorous to the observer to the point of being rough, because the young are rolled over, pushed, and even held with a paw during the "mothering." The primate mother is also very rough with the young as can be seen in grooming, playing, and exercising activities (15). Varying stimulation is also characteristic of the mother-child relationship of humans. The mother rocks, pats, grooms, and talks to the baby.

B. Problem

The major hypothesis of this paper is that as a result of the mother supplying varying exteroceptive and proprioceptive stimulation to the infant animal, the infant associates the varying stimulation with the stimulus characteristics of the mother. This association results in the mother coming to elicit approach responses from the young animal. These approach responses are later generalized to other animals having similar stimulus characteristics—the species. It is the purpose of this experiment to demonstrate only the first step of the development of the preference for the species. That is, a visual pattern which has been presented to young animals in conjunction with varying exteroceptive or proprioceptive stimulation will come to elicit approach responses from the animals.

Dogs were used in this study because of the wealth of information that is available on the maturation of their sensory modalities. Puppies respond to tactile, thermal, gustatory, and olfactory stimuli at birth, but do not respond to visual and auditory stimuli until approximately 18 days of age (6, 12). Puppies were trained and tested at the third and fourth week of age because Scott (10) has suggested that there is a critical stage in the development of puppies at this age, when they begin to respond to their surroundings as vision and hearing mature.

Emotional-disturbance estimates were made during training and testing in order to examine the effect of varying stimulation on the 3-week-old puppy and to obtain another measure of the puppy's attachment to the visual pattern during tests. It was hypothesized that the *S*s which received varying stimulation would be less emotionally disturbed in the tests with a stimulation circle than in tests alone, while there would be no difference in emotional disturbance for those *S*s which were not given varying stimulation during training.

C. Method

1. *Subjects*

The *S*s used in the experiment were from nine litters of purebred dogs. The total group of *S*s consisted of eight miniature poodles, 10 English cockers, seven German shepherds, and five Shetland sheepdogs. The assignment of *S*s to the five groups was random with two restrictions: every breed was represented in every group, and each group contained the same number of *S*s.

All puppies were reared by their natural mothers, with the exception that two of the English cockers were fed and cared for by one of the poodle mothers. All *S*s had been handled by their owners or by the kennel managers prior to training. The handling varied from almost daily petting to weekly examinations.

2. *Apparatus*

The training box was 25 inches long, 13 inches wide, and 17 inches tall. It was constructed from brown pegboard and had no bottom or top. The wooden stimulation circle was 5-1/2 inches in diameter and painted flat white. On training days, the box was placed on a cement floor, and the circle was fastened inside and at one end of the box. The circle was located with its center 7 inches above the floor and equidistant from the sides.

The box, used for the open-field tests, was constructed of quarter-inch plywood, and each side was 6 feet long and 4 feet high. Inside the box, and attached to one side, was one end of the pegboard box which had been used during training. This is shown in Figure 1. During the tests with the circle, the white circle was fastened to the end of the pegboard box, 8 inches from the floor. A 2-by-2-foot plywood platform lay on the floor, immediately in front of the pegboard. Attached to the sides of the platform were five micro-switches which were wired to an electric clock. The switches were activated by *S*'s placing two or more paws on any exposed portion of the platform, so that the clock was recording when *S* was on the platform. The clock, which was calibrated in tenths of a second, could record up to 600 seconds. It was located outside of the box.

3. *Procedure*

Each *S* was given three training trials a day, beginning when the *S* was 21 days of age and continuing through the 27th day of age. For each trial, *S* was removed from its whelping box and placed in the training box for three minutes. During this trial, *S* was held in the box, facing one end, with *E*'s hand under its stomach and chest, so that *S*'s rear paws touched the floor. *S*s in Groups I-IV faced the white circle. The circle was removed from the box when *S*s in Group V (no stimulation, no circle) were in the box. The groups were differentiated in the following ways,

a. Group I. *S*s were stroked one to three times per second on the back of the head, the neck, and on the back with a moderate pressure of *E*'s hand in a manner described by Bovard as Type I handling (1). One stroke consisted of a cephal-caudal movement of the hand followed by a caudal-cephal movement of the hand (rubbing w/circle).

b. Group II. A light from a flashlight was flashed on the circle one to three times per second. One flash of the light consisted of turning the light on by depressing a button on the flashlight and turning it off by releasing the button (flashing light w/circle).

c. Group III. *S*s were rocked back and forth one to three times per second with their rear paws touching the floor. As *S* was rocked, its head moved forward approximately one inch and then back one inch (rocking w/circle).

d. Group IV. *S*s were held in the box in the same manner as the *S*s in Groups I-III, but the stimulation was not varied (no stimulation with circle).

e. Group V. *S*s were treated in the same manner as Group IV except that the circle was not present (no stimulation and no circle).

Upon the completion of a trial, *S* was returned to the whelping box. Each

S received two trials in the morning and one in the late afternoon. The morning trials were separated by at least 30 minutes.

The sound emitted by each *S* was rated during each minute of a training trial. The ratings were made as follows, 0—no sound, 1—whining, 2—yelping, and 3—continuous yelping and howling. The ratings for the three minutes were summed, which permitted a maximum rating of 9 for each training trial. An average rating of the 21 training trials was obtained for each animal. The *E* had made similar ratings in a previous study (8).

All animals were tested on Days 28 and 29. On each test day, each *S* was placed in the open-field box for 3-1/2 minutes, once with the circle present and once with it not present. In all tests the *S*s were placed 6 inches in front of the platform facing the pegboard. Half of the animals in each group were first tested with the circle present and then retested alone. The other half of each group received the opposite order. On Day 29 the orders were reversed. On each day, the interval between tests for each *S* was approximately 30 minutes.

Three criterion measures were obtained from each test. The length of time each *S* was on the platform was automatically recorded by the clock connected to the microswitches attached to the platform. The time on platform when the circle was present was assumed to be an estimate of the attachment of the puppies to the circle when compared to the time on platform when the circle was not present.

Two measures of emotional disturbance were also obtained for each test. The *E* recorded with a stopwatch the length of time during which the *S* made sound (whining, yelping, or howling). Ratings of the type of sound were also made in the same manner as that described for training trials. It was assumed that the longer the animal vocalized, and the higher the rating, the more emotionally disturbed the animal was.

D. RESULTS

The number of animals from the various breeds differed among the training groups. In order to investigate differences in emotionality among the groups, one animal from each breed was randomly drawn from each group to obtain equal breed representation across groups. In those groups where only one of a breed was present, that *S* was used as the breed representative. This procedure resulted in four animals in each of the five groups for training comparisons. All six animals within each group were used in test comparisons.

Table 1 shows the means and the standard deviations of the ratings of the sounds made during training trials. The ratings from the 21 training trials were averaged for each *S*, and a mean of these mean ratings was obtained for each group. These sound ratings varied considerably among groups. In the visually stimulated group (Group II) and in the nonstimulated groups (Groups IV and V), there was considerable whining, yelping, and howling while the animals were held in the box. The *S*s in Groups I and III (rubbing and rocking, respectively) made very little noise during training trials.

TABLE 1
RATING OF TYPE OF SOUND DURING TRAINING
($N = 4$ per group)

	Type of training				
	Stimulation w/circle			No stimulation	
Parameter	Rubbing	Rocking	Flashing light	W/circle	No circle
Mean	.11	.68	2.44	2.71	1.74
SD	.14	1.36	1.61	1.22	1.31

The groups were ranked for each breed, and the Friedman two-way analysis of variance (13) was used to test for differences in emotional disturbance among groups during training. The χ_r^2 of 12 was significant at the .02 level.

The three dependent variables were analyzed separately. The measures used in each analysis were the mean of the measures obtained from the two tests with the circle, and the mean of the measures obtained from the tests with no circle present. The analysis-of-variance design used was similar to the three-factor, Type III design of Lindquist (7, pp. 281-284), but had a fourth factor nested in one of the other factors. This allowed a comparison of the stimulated groups and the nonstimulated groups, a comparison of the groups nested within each of these two levels of stimulation, a comparison of the tests with the circle and the tests without the circle, and a comparison of the two different orders in which the tests were presented. The orders of presentation were compared, because having been in the open-field box first with the circle might affect the animal's subsequent behavior when the circle was not present.

Table 2 shows the mean platform times for each training group in each test. The *S*s stimulated during training trials spent more time on the platform when the circle was present than when they were alone.

The results of the analysis of variance of platform time are shown in Table 3.[3] It can be seen that the stimulation groups did not differ significantly

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[3] Since the variances of the distributions of platform times were found to be significantly different, a more conservative level of significance was chosen for the analysis of variance test ($p < .03$) as suggested by Lindquist (7, pp. 78-90).

TABLE 2
TIME (IN SECONDS) ON PLATFORM DURING TESTS

	Type of training				
	Stimulation w/circle			No stimulation	
Parameter	Rocking	Rubbing	Flashing light	W/circle	No circle
Alone					
Mean	42.93	29.17	40.03	29.18	48.85
SD	10.54	29.15	25.28	21.66	49.63
W/circle					
Mean	56.65	57.17	69.17	29.42	47.97
SD	28.97	8.31	33.18	23.43	46.65

from the no-stimulation groups when the platform times in both types of test conditions were considered together. However, the interaction between level of stimulation and type of test was significant ($p < .03$). This interaction indicates that there was a significant difference in time on platform between tests with the circle and tests with no circle for the stimulated animals but not for the nonstimulated animals. The difference between the two types of tests for the stimulated animals was large enough to make the difference between tests significant for all groups. Individual comparisons by t tests between circle and no-circle tests for each stimulated group yielded t's that were significant at the .05 level.

The means and the standard deviations of the two different estimates of emotional disturbance in the tests are shown in Tables 4 and 5. All groups

TABLE 3
ANALYSIS OF TIME ON PLATFORM DURING TESTS

Source	*df*	*MS*	*F*
Training (Stimulation vs. No Stimulation)	1	1537.19	
Groups within Stimulation	2	395.46	
Groups within No Stimulation	1	2190.77	
Order of Tests	1	76.16	
Order by Levels of Stimulation	1	2983.10	
Order by Groups within Stimulation	2	159.10	
Order by Groups within No Stimulation	1	2202.25	
Error (Subjects in Groups by Order)	20	1581.54	
Tests (Circle vs. No Circle Present)	1	2956.88	7.92*
Tests by Levels of Stimulation	1	2063.57	5.53*
Tests by Groups within Stimulation	2	221.49	
Tests by Groups within No Stimulation	1	1.84	
Tests by Order	1	29.44	
Tests by Order by Groups	4	397.67	
Error			
Tests by Subjects in Groups by Order	20	373.33	
Total	59		

* $p < .03$.

spent less time crying and had lower sound ratings during tests with the circle than in tests alone. However, three of the six dogs in each of the no-stimulation groups cried longer and had higher ratings in tests with the circle than in tests alone.

TABLE 4
SOUND DURATION IN SECONDS DURING TESTS

	Type of training				
	Stimulation w/circle			No stimulation	
Test	Rubbing	Rocking	Flashing light	W/circle	No circle
Alone					
Mean	110.67	94.17	104.17	126.33	96.17
SD	47.44	32.16	38.15	46.12	48.73
W/circle					
Mean	83.17	86.50	77.00	103.83	86.83
SD	34.77	49.55	36.74	51.99	47.66

TABLE 5
RATING OF TYPE OF SOUND DURING TESTS

	Type of training				
	Stimulation w/circle			No stimulation	
Test	Rocking	Rubbing	Flashing light	W/circle	No circle
Alone					
Mean	3.58	3.21	2.94	3.79	3.29
SD	2.15	1.25	1.15	1.84	1.95
W/circle					
Mean	2.17	3.12	2.33	3.58	3.08
SD	1.66	1.86	1.62	2.28	1.91

Table 6 presents summaries of the analyses of the measures of emotional disturbance. The two orders of testing were significantly different for the sound-duration variable ($p < .05$), and the interaction of order with level of stimulation approached significance ($p < .10$). The *S*s in the nonstimulated groups and those that were rocked during training cried longer in all open-field tests if they were tested alone first than they did when tested with the circle first. The difference in duration of sound for all groups between the two types of tests resulted in an *F* of 7.57 ($p < .05$).

The *F* test of the difference in sound ratings between types of tests was highly significant ($p < .01$). The interaction between Tests and Levels of Stimulation was not significant ($p < .20$).

E. DISCUSSION

The results of the analyses of the ratings made during training indicated that the type of treatment during training significantly affected the kinds of

TABLE 6
ANALYSIS OF MEASURES OF EMOTIONAL DISTURBANCE IN TESTS

Source	*df*	Duration of sound *MS*	Duration of sound *F*	Rating of sound *MS*	Rating of sound *F*
Training (Stimulation vs. No Stimulation)	1	1642		4.3319	
Groups within Stimulation	2	167		.8454	
Groups within No Stimulation	1	3337		1.6276	
Order of Tests	1	17579	7.12*	13.8913	2.28
Order by Levels of Stimulation	1	10573	4.28	6.5367	
Order by Groups within Stimulation	2	1720		4.2286	
Order by Groups within No Stimulation	1	196		1.6302	
Error (Subjects in Groups by Order)	20	2470		6.1022	
Tests (Circle vs. No Circle Present)	1	5320	7.57*	3.5673	8.66**
Tests by Levels of Stimulation	1	86		.9120	2.21
Tests by Groups within Stimulation	2	387		1.2778	3.10
Tests by Groups within No Stimulation	1	260		.0026	
Tests by Order	1	874		.9703	2.35
Tests by Order by Groups	4	194		.0066	
Error (Tests by Subjects in Groups by Order)	20	702		.4120	
Total	59				

* $p < .05$.
** $p < .01$.

sounds the dogs made during training trials. Being rubbed and rocked in the presence of the circle resulted in less-intense sounds than exposure to the flashing light or either of the control conditions. The sound ratings are considered to be an index of emotionality (2, 8, 11). This finding suggests that the emotional disturbance of 3-to-4-week-old puppies is dependent upon the kind and intensity of stimulation. Hebb (3) has suggested that a mild degree of stimulation is pleasing but a high degree of the same kind of stimulation can bring about emotional disturbance. The stimulation supplied to the puppies by the light may have been more intense subjectively than the rubbing and rocking, but this interpretation does not explain the behavior of the control groups whose sound ratings were similar to those with the flashing light.

The different treatments in training also resulted in differences among the groups in test measurements. The interaction between types of tests and levels of stimulation was significant as measured by time on platform. That is, the groups that received varying stimulation in the presence of the circle during training spent more time on the platform during tests with the circle than during tests alone. However, the groups that were not given varying stimulation during training did not spend more time on the platform when tested with the circle than when tested alone. (See Table 2.)

Furthermore, the interaction of tests with stimulated groups and the interaction of tests with nonstimulation groups were not significant in the analysis of variance of platform time. This means that the groups which had received different kinds of varying stimulation in training did not differ on platform times in either test condition. In addition, the *S*s which had faced the circle during the training trials but which had not received varying stimulation during these periods (Group IV) did not differ in platform time from the *S*s that had neither been stimulated nor had faced the circle during training (Group V).

The time on platform was considered to be a measure of the degree of attachment of *S* to the circle. The *S*s, from 3 to 4 weeks of age, that were given varying tactile stimulation (rubbing), varying kinesthetic stimulation (rocking), and varying visual stimulation (flashing light) while facing a visual pattern showed a stronger attachment to the pattern at 4 weeks of age than did *S*s that were not given varying stimulation but that had faced the pattern during training. Also the latter group of *S*s did not show any more attachment to the visual pattern than did *S*s which had never seen the pattern prior to testing.

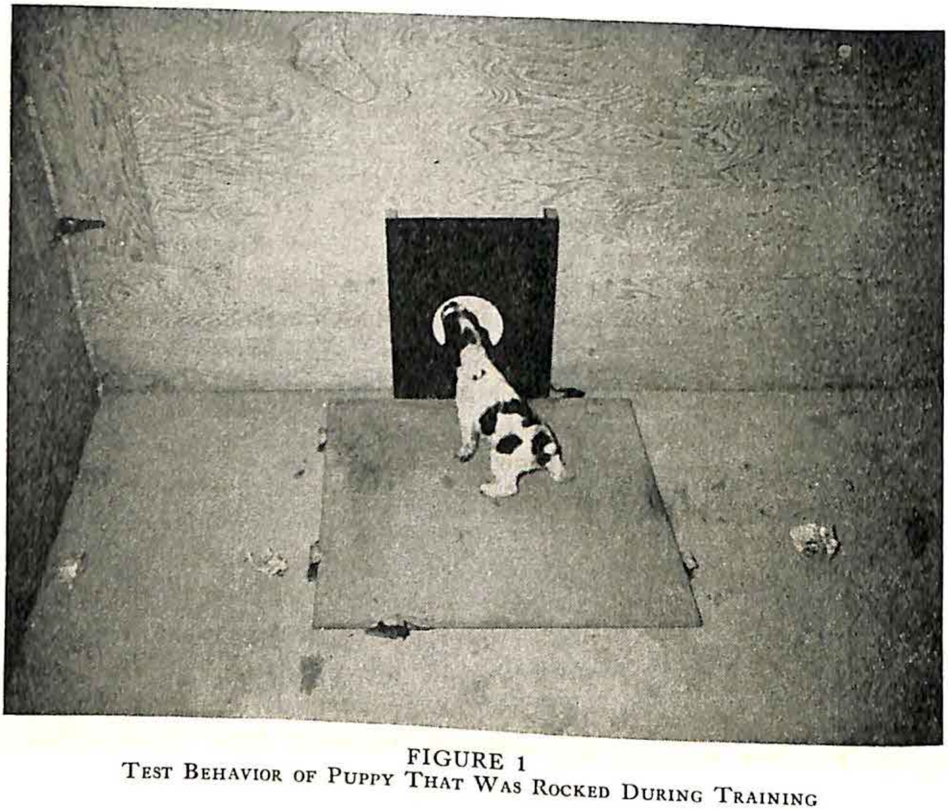

FIGURE 1
Test Behavior of Puppy That Was Rocked During Training

Another explanation would involve the postulation of anxiety reduction instead of varying stimulation as the reinforcement for the behavior observed in this study. Moltz (9) has proposed such a theory of anxiety reduction to explain imprinting phenomena. The application of this theory to the results of this study would require that the circle be associated with the reduction of anxiety for the groups that received varying stimulation but not for those groups which had not received varying stimulation during training. The sound ratings taken during training were considered to be a measure of the emotional disturbance of the *S*s and could also be considered a rough measure of the anxiety of the animals during the training sessions. Because there were significant differences in anxiety among the stimulation groups, and because these groups did not differ in the measure of attachment to the circle during testing, it would be difficult for an anxiety-reduction theory to explain these findings.

The results of this study indicate that the association of varying exteroceptive and proprioceptive stimulation with a visual pattern results in the visual pattern eliciting approach responses in the dog. In order to show that this association is part of the process by which the dog learns its species characteristics, it is necessary to demonstrate that the approach responses elicited by the visual pattern would also be elicited by visual patterns with similar stimulus characteristics. If generalization from one pattern to a similar pattern could be demonstrated, the process by which the dog develops its preference for its own species could be better understood.

Imprinting has been described as a process or mechanism by means of which certain visual stimuli acquire with extreme rapidity the capacity to elicit responses that an animal ordinarily directs only towards members of its own species (14). This study suggests that the association of varying stimulation with the visual stimuli is part of this process in dogs. The puppy ordinarily does not learn to make these responses to other animals, because the only objects associated with varying stimulation in the first few weeks of life are the bitch and the litter mates. In the natural state, the bitch prevents any other mammal from entering the den, and the pups do not normally venture outside the den until 4 weeks of age.

It was also hypothesized in this study that *S*s which had received varying stimulation during training while facing the circle would be less emotionally disturbed in those tests with the circle present than in the tests in which the circle was not present, while there would be no difference in emotional disturbance for those animals that were not given varying stimulation during training. The two measures of emotional disturbance were duration and ratings of sound during test trials. The results of analyses of both measures show that all groups were less emotionally disturbed in those tests with the circle than in tests alone (Tables 4 and 5). Furthermore, the interaction of types of tests and levels of stimulation was not significant for either measure of emotional disturbance (Table 6). This means that the decrease in emotional disturbance from tests alone to tests with the circle for stimulated animals was not greater than the decrease for control animals.

Observations of the puppies in the open-field box with the circle showed that a puppy would characteristically stop crying while approaching the circle and then would resume crying after it reached the circle, regardless of whether it left the platform or sat down facing the circle. These short lapses in sound when approaching the circle could account for the general drop in rating and duration of sound for animals in all groups from tests alone to tests with the circle.

One of the reasons for the resumption of crying by the stimulated animals after they reached the circle may have been their lack of familiarity with the odor of the circle. That is, an object that was familiar in appearance was not familiar in odor. The encounter of the animals with the circle during the open-field test was the first time that they had been allowed to approach and to smell the circle. In the training box, they were held about 1-1/2 feet from the circle during stimulation. In a previous study (8) puppies that had been reared by their natural mother in the presence of a toy cloth animal showed less emotional disturbance in an open-field test if the toy cloth animal was present than they did in the test alone. Those pups had slept next to the toy, climbed on it, chewed on it, etc., for the first four weeks of life. They had also been stimulated by the mother in the presence of the toy. The pups in this experiment were stimulated in the presence of the circle, but were not allowed any other association with it.

The order of tests was significant ($p < .05$) in the analysis of variance in terms of the variable of duration of sound (Table 6). The animals that were tested first with the circle cried for shorter periods of time in both tests than the animals that were tested alone first. This difference is difficult to interpret, because the order of tests was confounded with breeds, sex, and the number of animals that had preceded any other animal into the test box.

F. SUMMARY

It was hypothesized that a visual pattern presented to puppies in conjunction with varying exteroceptive or proprioceptive stimulation will come to

elicit approach responses from the animals. Thirty dogs were trained at 3 weeks of age and tested at 4 weeks of age. Each experimental animal was rubbed, rocked, or subjected to a flashing light while facing a visual pattern. The control animals were not given varying stimulation, but half of them faced the pattern during training periods. The attachment to the pattern and the emotional disturbance of each *S* were measured in open-field tests.

Ratings of emotionality of *S*s during training were found to be a function of the quantity and the quality of stimulation they recevied. From the analyses of the test results, it was concluded that puppies that received varying simulation while facing a pattern in training were more attached to the pattern during tests than were puppies that had faced the pattern but had not received varying stimulation during training. The latter group showed no more attachment to the pattern than did the *S*s that had not seen the pattern prior to testing. These findings suggested that varying stimulation is an important variable in the learning of the species characteristics in the dog.

All groups were less emotionally aroused in tests with the pattern than in tests alone. This difference was related to behavior observed during the tests and previous experience with the pattern.

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